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REPORT
OF THE
SPECIAL COMMITTEE
OF THE
UNITED STATES SENATE
ON THE
IRRIGATION AND RECLAMATION OF ARID LANDS.

REPORT OF COMMITTEE AND VIEWS
OF THE MINORITY.

WASHINGTON:
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IN THE SENATE OF THE UNITED STATES.

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MAY 8, 1890.—Ordered to be printed.

Mr. STEWART, from the Select Committee on Irrigation and Reclamation of Arid Lands, submitted the following

REPORT:

[To accompany S. 2104.]

Before giving a detailed account of the investigations of your committee, some general observations and suggestions as to what action should be taken by the Government to enable the people to reclaim and settle upon the arid lands of the United States are submitted.

Over two fifths of the area of the United States, exclusive of Alaska, requires irrigation to insure regular crops, and in at least four-fifths of the arid region irrigation is a necessity for the production thereof. This arid region comprises between 1,200,000 and 1,300,000 square miles, being a third larger than British India and very similar to it in its general characteristics.

Attention is called first to that portion of the great plains between the Canadian line and Mexico, and the foot-hills of the Rocky Mountains and a line following where the rain-fall ceases to be sufficient to produce regular crops. This line is not a straight one. It curves both east and west, and is sometimes found about the ninety-eighth meridian of west longitude, and sometimes as far west as the one hundredth meridian. This region contains about 200,000 square miles. The soil is exceedingly fertile and the climate salubrious; and in the eastern part of it, while irrigation is important, farming can be prosecuted, except in seasons of drought, without irrigation. Still for a portion of each summer a supply of water under the farmers' control would always be of great importance.

The Missouri River with its numerous branches; the Platte River, also with several branches; the Arkansas, and a number of other streams of less importance, flow through these plains. To what extent these rivers and their tributaries, together with the water that may be stored in reservoirs which now runs to waste, carrying silt and increasing floods in the Lower Mississippi, may be utilized, is as yet undetermined. It is confidently believed that, with restraining dams to hold back the water of the numerous lakes found at the headwaters of the various tributaries of these rivers, and reservoirs constructed at other suitable points, together with the aid of the natural flow of the streams, a very large extent of country, now comparatively worthless, could be made exceedingly productive, while the floods in the Lower Mississippi would be greatly alleviated.

The rain-fall on these great plains comes not in gentle showers with cloudy weather, as is the case farther east, but falls in torrents upon limited areas; sometimes in one place and sometimes in another; and

it often happens that while a violent storm is raging in one locality, a few miles distant there will be sunshine and a clear sky.

Experience has shown in Kansas, Nebraska, and other localities, where the country is settled and the land cultivated, that this erratic and irregular rain-fall is greatly modified and the moisture more evenly distributed. It is believed, from the experiences of this and other countries, that as settlement advances the climatic conditions will be very much improved, although there may not be much increase in the aggregate of precipitation. It is also anticipated that much irrigation may be practiced throughout these plains by the local storage of the storm-waters in small artificial reservoirs constructed by the farmers themselves.

There is another and a very remarkable development of water supply in various portions of these plains. Artesian wells have been bored along the valley of the James River, in the States of North and South Dakota, which surpass in the flow of water any wells in the United States, and probably any in the world. Wells have also been bored with success in Colorado, Kansas, Texas, and other places east of the Rocky Mountains.

All the country west of the eastern base of the Rocky Mountains to the Pacific Ocean requires irrigation, except that part of Washington, Oregon, and northern California west of the Cascade Mountains, and comparatively small areas in eastern Oregon, Washington, and northern Idaho, which receive moisture from the storms of the Pacific Ocean passing through the gap in the Cascade Mountains where the Columbia River flows. This arid region includes Montana, Idaho, Wyoming, Utah, New Mexico, Arizona, Nevada, nearly all of California, the larger portion of Colorado, Oregon, and Washington, and more than one-third of Texas.

The principal rivers and streams are the headwaters of the Missouri, the Platte, the Arkansas, the Rio Grande, and Red on the east of the summit of the Rocky Mountains. The great basin between the Rocky and the Sierra Nevada Mountains is drained by the Colorado and the Columbia Rivers and their tributaries. The principal ranges of mountains are the Rocky, the Sierra Nevada, the Cascade, the Wasatch, and the Bitter Root.

A GENERAL DESCRIPTION.

Montana extends from the one hundred and fourth degree of longitude to the one hundred and sixteenth degree of longitude, west from Greenwich, and is bounded on the north by the British possessions, and on the south by Idaho and Wyoming. It contains 143,776 square miles. While it equals, if it does not surpass, any other State or Territory of the United States in mineral resources, it has a vast amount of good agricultural land, and an abundant supply of water for the purpose of irrigation. The eastern half of the State is watered by the numerous branches of the Missouri River, which head in high mountains where the precipitation is very great. The streams are of such an altitude as to afford an opportunity to divert them over very large areas of the most fertile land. The western half of the State is watered by the tributaries of the Columbia River, which find their sources in the Rocky Mountains, and flow west through numerous fertile valleys. The agricultural capacity of the State is very great, and the farmers in this region have great advantages in the home market created by extensive mining operations carried on, which must be continued for an indefinite period.

Washington, east of the Cascade Mountains, would be greatly benefited by irrigation, and large areas of it must be irrigated to produce crops. It is, however, more favorably situated than any of the other interior States on account of the great opening in the Cascade Mountains through which the Columbia River flows. The mouth of the Columbia River is a great storm center. The western or Chinook winds in winter focusing there, drive the clouds through the Columbia River Pass and their contents are precipitated when they strike the Bitter Root Mountains in northern Idaho and other elevations in eastern Oregon and western Montana and Washington. In these localities farming is successfully conducted without irrigation, although in most places the practice would be highly beneficial. There are large sections not reached by sufficient rain-fall, occasioned by the passage of clouds through the Columbia River Pass. These sections must be cultivated, if at all, by irrigation. To what extent the Columbia River and its tributaries may be utilized for this purpose in eastern Oregon and Washington is not yet determined. There is a large extent of Oregon east of the Cascades which possesses great natural fertility, but it is entirely dependent upon irrigation.

Idaho comprises 86,294 square miles. The northern part of it, commonly known as the Pan Handle, is well supplied with water, and farming is prosecuted with success without irrigation, although it would be of great advantage, and the water for that purpose can be easily obtained. The great valley of southern Idaho, through which the Snake River and its tributaries flow, is the largest interior valley in the United States which can be irrigated by one general system. The Snake River passes through this great valley and heads with its numerous branches in the high mountains of Wyoming, near the Yellowstone Park, where there are numerous important lakes which can be utilized as reservoirs to keep back the flood waters until the season of irrigation. The land of this great valley is exceedingly productive. That in the vicinity of Boise City is already under a high state of cultivation, producing all the crops and fruits of the temperate zone to perfection and in great abundance. The climate is mild, being modified by the Chinook winds from the Pacific Ocean passing through the opening in the Cascade Mountains where the Columbia River flows. Their effects are felt in Montana and as far east as Utah. Idaho is also celebrated for its mineral resources and has, like Montana, a most important home market for its agricultural products.

Wyoming comprises 97,883 square miles. Much of this Territory lies at a high altitude, and its mountain peaks are covered with perpetual snow. It abounds in mineral resources, particularly in coal and iron. Its coal mines along the line of the Union Pacific Railroad are already being developed on a magnificent scale. It also has great agricultural resources. The line of the Union Pacific Railroad passes through the least inviting portion of the Territory. The traveler over this thoroughfare will necessarily underrate the value of Wyoming as an agricultural country, but it is now ascertained that the Laramie Plains and other parts of the Territory traversed by the Union Pacific Railroad, when irrigated, produce cereals and the hardier vegetables in great abundance. The northern part of the Territory is, however, the best agricultural country. The Yellowstone and other branches of the Missouri have their sources in Wyoming, and the numerous valleys through which they flow produce all the crops and fruits of the temperate zone. There are also large areas in the eastern part of Wyoming that can be irrigated and brought under cultivation. There can be no question about the natural resources of this Territory and that it is capable of

supporting a very large population. It also has a home market which must increase indefinitely as its coal and iron mines are developed and utilized.

Colorado comprises 104,500 square miles, and it possesses many natural advantages. The Platte and Arkansas extend their branches into the Rocky Mountains, which constitute the backbone, so to speak, of this State, and their waters are already distributed over many thousands of acres of irrigated land. The Rio Grande also heads in the mountains of this State, and before it enters New Mexico passes through extensive valleys which are rapidly being brought under cultivation by irrigation works of great extent. On the western slopes, in the valleys of the Grande and Uncompahgre Rivers, there are considerable areas under ditch. Colorado is drained on the west by the Colorado River and its tributaries. It is also a great mineral State and contains mines of almost every description. It abounds in gold, silver, iron, and coal. The enterprise of the people of this State seems to know no bounds. The wisdom of its laws regulating the use of water challenges the admiration of all who investigate them. The success of the pioneers of this State in reclaiming the desert by means of irrigation, and their wisdom in legislating for its regulation, furnish examples which are worth following throughout the arid region.

Utah comprises 84,476 square miles. Here irrigation was first begun in the United States by the Anglo-Saxon race. It was inaugurated in 1848 by the Mormons when this was the most isolated portion of the continent between the British line and the City of Mexico. The frugality, enterprise, and perseverance of the Mormons in reclaiming the desert lands of Utah, and their mode of distributing the water and dividing the land among their people, furnish an example of what is possible in the arid region, and has already done much to encourage the pioneers of the West to build up States in a country which fifty years ago was designated on the maps as the Great American Desert. A person familiar with the history of the Mormon settlements in Utah, their hardships, privations, and successes, must necessarily sympathize with them as a people and look forward with anxiety and hope to the day when their institutions will be in harmony with the laws of the United States, and Utah be permitted to join the sisterhood of States. The Great Salt Lake basin is watered by rivers and streams flowing from the Wasatch Mountains, the Bear and the Jordan being the largest. The amount of land under cultivation by irrigation in this Territory is about 600,000 acres, which may be increased to 3,000,000 acres when the waters which are found in it and which flow through it are utilized and properly distributed. Utah has also mineral resources of vast extent, which are comparatively untouched. It has extensive coal-fields, rich and valuable mines of gold, silver, and lead, furnishing an important home market.

Nevada comprises 112,090 square miles. It abounds in mines of gold, silver, copper, salt, borax, and other minerals. Its agricultural resources by irrigation are sufficient, when developed, to support a large population. The western part of the State is watered by the Truckee, Carson, and Walker Rivers, which head in numerous lakes in the Sierra Nevada Mountains, where the precipitation is greater than in any other part of the United States, except in the Cascade Mountains in Washington. These streams flow into Nevada and sink in the sand or form lakes. It is estimated that from a million to a million and a half acres of land may be irrigated by these streams. The Humboldt River heads near the Utah line, and the Central Pacific Railroad passes through

the valley of this river for about 250 miles. Much of this valley may be reclaimed by storing, and an economical use of the water. This river has many branches and fertile valleys, both to the north and to the south, which are already cultivated to a considerable extent by means of irrigation. While there are large parts of the State that must remain deserts for want of water, still there are valleys interspersed in the mountains throughout the State of exceeding fertility, and for which water can be procured for irrigation. In the southern part of the State there is a large extent of rich land, and the remains of irrigation works found in that vicinity show that the country was once inhabited by a race which cultivated the soil. The people of Nevada were at first exclusively engaged in mining, the agriculture that was pursued being solely for the purpose of supplying mining camps. But they are now turning their attention to agriculture with good success. This State will also have the advantage of a large home market in supplying the mining communities.

California is one of the most remarkable States in agricultural resources, variety of climate, and products in the United States, and probably is unsurpassed by any country in the world. It also commenced its career as a mining State, and for twenty-five years after the discovery of the gold mines little attention was paid to agriculture. It is noteworthy that the great valleys of California, now so productive, were regarded a few years ago as deserts, and were occupied only by roaming herds of Mexican cattle. Irrigation in this State is being developed on a grand scale and with wonderful success. Land that remained subject to private entry at \$1.25 per acre for twenty-five or thirty years now commands \$100 to \$1,500 per acre, and a family can secure all the comforts of life upon 20 acres of this land. The work of irrigation in this State has only just begun. Enough has been accomplished, however, to demonstrate the fact that the possibilities of the growth and development of this country must continue indefinitely. Cities have sprung up within the last ten years in its alleged deserts, which rival the splendor of the most prosperous centers of the Atlantic States.

The methods adopted for irrigation in California furnish valuable lessons. They show that year by year the supply of water becomes more plentiful for new fields as the ground becomes saturated. It is estimated by the best judges that nearly all the valley land of California may be ultimately brought under cultivation by irrigation. The Sierra Nevada Mountains, as before remarked, are lofty, and the snow and rain that fall on them during ordinary seasons is simply immense. The Sacramento, the Feather, the Yubas, the Bear, the American, the Tnolumne, the Stanislaus, the Merced, the Kings, the San Joaquin, the Kern, and many smaller streams flowing from the Sierra Nevada into the great valley of California, when utilized with a proper high storage system in the mountains, will be found amply sufficient to bring under cultivation all the valley land from Red Bluffs to the Tehachapi Pass, a distance of about 500 miles with an average width of about 40 miles. The great valley of southern California, bounded on the west, north, and east by mountain ranges connecting with the Sierra Nevada Mountains, and on the south and west by the Coast Range and the Pacific Ocean, is fast becoming the most highly cultivated and productive part of the United States, abounding in semi-tropical fruit of all kinds as well as the productions of the temperate zone. A visit to its beautiful vineyards and its prosperous towns offers a new revelation to the traveler.

Arizona comprises 113,916 square miles. No part of it can be cultivated without irrigation. The southwest section of the Territory lies very low. The climate is warm and healthful. Its products are also semi-tropical. The grape, the orange, the fig, the date, the apricot, and all other fruits and products of the temperate and semi-tropical countries are cultivated here to perfection. The Colorado River, although furnishing an abundance of water, can not be utilized to any extent in Arizona without great expense. It may, however, be used above to reclaim a large section of country in California known as the Mojave Desert. This matter has not been fully investigated. The Gila and its branches are the principal streams of southern Arizona. This river discharges an immense volume of water in the wet season, but in the dry season it sinks and flows under the surface for miles on each side. The engineering problem to be solved here is how to bring this water to the surface. There are points where it crosses reefs of rock where dams can be constructed and the water conveyed in canals to reclaim large sections of country. The largest tributary of this river is known as Salt River. In the vicinity of the town of Phoenix, on Salt River, about 100,000 acres of land are already irrigated. The facilities for storing the water of Salt River are very good, and where the river leaves the mountains an immense reservoir of water may be had at comparatively small expense, which would irrigate an extensive region of country. This section is well adapted to the grape, orange, lemon, and other semi-tropical fruits. It also produces the cereals and all other crops of the temperate zone. There are many other parts of this Territory that can be reclaimed by irrigation. As a mining country it will furnish a valuable home market. There is no doubt of the capacity of Arizona to support a large and prosperous population.

New Mexico comprises 121,201 square miles. Along the valley of the Rio Grande the country has been cultivated by the Mexicans from a very remote period. The supply of water, however, for this Territory is very much diminished by irrigation at the headwaters of the Rio Grande in the State of Colorado. To what extent the waters of this river can be stored and utilized is a problem not yet solved, but it is confidently believed that, by storage of the flood waters, a very large extent of country, in addition to that heretofore cultivated, may be irrigated from the Rio Grande. There are numerous other streams in the Territory which are being diverted and utilized for irrigation. Water is also found under the surface in many parts of the Territory, and by means of pumping and flowing wells a sufficient supply may be obtained to reclaim much of the desert land. The Pecos River, in the eastern part of the Territory, is an important stream and is being diverted on a large scale by canals. This river extends into Texas, where it enters the Rio Grande, and may also be used, and is now being used, to reclaim a portion of that State. The Mexican grants, which cover a large part of the Territory of New Mexico, have been a drawback to its development, but the time is not far distant when these titles will be settled and the land divided up, as it is now being done in California. New Mexico has great mineral resources, particularly coal, which is found in abundance. Taken all in all its future will surpass what the most sanguine have heretofore anticipated.

The western half of Texas, which was supposed to be uninhabitable, constituting in that section the plains region first mentioned, will be largely reclaimed by the use of the running streams, artesian wells, and pumps. The experiments already made there have demonstrated that a large part of it may be reclaimed and rendered exceedingly fertile by such irrigation. Artesian wells have been bored in various

places throughout the arid region frequently with good success. California has several important artesian belts, and is developing the underground flow of water to good advantage. Nevada has many artesian basins which will be utilized. The same is true of Utah, Idaho, Montana, Washington, Arizona, and New Mexico; but in the mountain region the running streams, supplemented by reservoirs for storage of storm waters must furnish the principal supply for irrigation.

Without further particulars at this place with regard to the arid region, it may be said that throughout its entire extent the grasses are more nutritious than where the rain-fall is sufficient to produce crops. The frequent rains in the Mississippi Valley and further east extract the nutriment from the plants and destroy the grasses, except when they are growing, so as to render them at other times comparatively valueless for stock; but in the arid region the vegetation, however dry, retains its nutritious properties, and stock will fatten where to the uninitiated it would be supposed they would starve.

Wyoming, Montana, the western portions of North and South Dakota, eastern Oregon, and Washington, Idaho, and Nevada are especially valuable for grazing purposes. The same is true to a large extent of Arizona, Utah, New Mexico, and Texas. This will be a perpetual source of wealth to the farmers who may cultivate the valleys by irrigation and use the uplands for pasture. Reclamation of arid lands will create cattle as well as arable farms, and tend rapidly to the division and use of the land in small parcels.

The amount of land that may be brought under cultivation in the arid region by irrigation is variously estimated at from seventy-five to one hundred and fifty millions of acres. It is safe to predict that at least one hundred millions of acres will be ultimately brought under cultivation by irrigation, and that, too, by the water in sight which, when properly utilized, will readily reclaim at least 10 per cent. of the whole arid area. It is worthy of remark that land cultivated by irrigation is much more productive than land where the rain-fall is sufficient to produce crops. The certainty of crops every year in an irrigated country where the water supply is sufficient is a most important consideration. Besides, in nearly every part of the arid region more than one crop can be produced each year from the same land, and a good crop is always certain with a constant water supply. Irrigation requires unremitting attention and high cultivation and with such attention and cultivation it is calculated that in any given period of ten years irrigated land will produce from three to five times as much as land cultivated by rain-fall.

The question for consideration is: What action should be taken by the Government to enable the people to reclaim these desert lands? The reclamation must be initiated and executed by the people, and not by their Government. In India, and, in fact, in all countries under monarchical or despotic rule, the work of irrigation has been carried on under Government control and largely with Government money. The Government of British India has already expended several hundred millions of dollars in constructing irrigation works, and is continuing such expenditures on a most magnificent scale. The reports show that the investment has been profitable to the Government and of the greatest possible advantage to the people.

But there is no necessity for the United States to engage in such expenditures. If the opportunity is furnished to the people of this country they will reclaim these desert lands so far as reclamation is necessary. The use of industrial co-operation in developing the mineral resources of the far West demonstrates the capacity of the people for great un-

dertakings which in other countries require vast expenditures of accumulated capital. A person who will visit these mining States and Territories, and see the hundreds of miles of canal constructed for mining purposes in the most difficult parts of the Sierra and Rocky Mountains, the bed-rock tunnels miles in length, the deep shafts, the reduction works, and other vast enterprises which the people themselves have conducted by co-operation and without accumulated capital, will not question the capacity of the pioneers to reclaim the deserts. If he will then turn his attention to Utah, Colorado, California, and other localities where irrigation is practiced, and witness what the people have already accomplished, all doubt as to the ultimate result will be removed. It is necessary, however, for the development of this arid country to give the people an opportunity by laws suitable to the situation and adapted to the purpose.

GOVERNMENTAL ACTION.

On the 3d day of March, 1873, the following act of Congress was approved:

That the President be, and he is hereby, authorized to assign two engineers of the Army and one officer of the Coast Survey now stationed on the Pacific coast, for the purpose of examining and reporting on a system of irrigation in the San Joaquin, Tulare, and Sacramento Valleys of the State of California, and for that purpose the officers so assigned may associate with themselves the chief of the geological survey of California, and also one other civilian distinguished for his knowledge of the subject.

SEC. 2. That these five persons shall constitute a board, with power to fill vacancies, whose duty it shall be to make a full report to the President on the best system of irrigation for said valleys, with all necessary plans, details, engineering, statistical, and otherwise; which report the President shall transmit to Congress at its next session with such recommendations as he shall think proper.

Under this act a commission was organized composed of General Barton S. Alexander, Col. George H. Mendell, Prof. George Davidson, and R. M. Brereton, a civil engineer who had large experience in irrigation in India. A most comprehensive and instructive report was made by the commission and published by Congress. (H. R. Ex. Doc. No. 290, Forty-third Congress, first session.)

This report gives much valuable information on the whole subject of irrigation in India and other countries, and furnished material to guide the people of this country. The report was exceedingly beneficial, pointing out the way to the development of the great valleys of California, and has resulted in great good.

The Department of Agriculture, without any operative or executive powers, has done a good deal to extend a knowledge of the character and resources of the arid region. It begun in 1865 with a report by a former delegate from Arizona, Charles D. Poston, and continued between that and 1886-'87 to publish valuable reports by the late George P. Marsh, Professor Hilgard, of California, ex-Governor Furness, of Nebraska, and others, closing with the important and valuable volume on "Irrigation in the United States," which the Senate ordered published in 1887. This very useful report was prepared by Mr. Richard J. Hinton, who has also efficiently served your committee during the past year as irrigation engineer and expert.

POLICY PURSUED BY THE DIRECTOR OF THE U. S. GEOLOGICAL SURVEY.

Subsequently the whole subject was turned over to the Director of the Geological Survey with general provisions for the classification of the public lands, he having previously prepared a valuable report on

the arid lands of the United States. The most important action by the Government in aid of the reclamation of desert lands was the passage of the acts of October 2, 1888, and of March 2, 1889. By the first of these acts \$199,000 was appropriated for topographic surveys, and \$100,000 for surveys pertaining to irrigation. Of the sum appropriated for irrigation \$60,000 was diverted by the Director from that purpose and added to the appropriation for topographic surveys, making the sum of \$259,000 for topography, and leaving only \$40,000 for irrigation.

By the act of March 2, 1889, \$200,000 was appropriated for topographic surveys, and \$250,000 for irrigation surveys. Of the sum appropriated for irrigation surveys \$120,000 was diverted from that purpose by the Director and added to the \$200,000 for topographic surveys, making the aggregate of \$320,000 for topography, and leaving only \$130,000 for irrigation surveys and the office and other expenses incidental thereto. Your committee regard this as a plain violation of the statute and a misapplication of the money.

In fairness to the Director, however, it is proper to state the substance of the reasons assigned by him for this use of the public money, together with the views of the engineers of the Irrigation Survey.

The provision of law authorizing this last appropriation sets forth in some detail the purposes to which it is to be applied, etc. Among those purposes it mentions "the necessary maps." The Director of the survey has construed the words "necessary maps" to mean topographic maps of the same kind as those that are provided for specifically in the first item of \$200,000, and he has applied more than half the irrigation item to that purpose, leaving less than half of the \$250,000 for the objects for which it was intended. It has always been held, both in Congress and by many decisions of attorneys-general and comptrollers, that when an appropriation is made for any specific purpose it is not lawful to apply any other appropriation to that purpose unless the law explicitly authorizes it. It would have been a most unjustifiable straining of interpretation to conclude that such vague and indefinite words as "necessary maps" meant so vast and costly an undertaking as a topographic map of the whole arid region, even if no specific appropriation for topography had been made. But when such an appropriation was specifically made, it should clearly have been held to be the only money which could be applied to topographical purposes.

It has been represented by the Director that a general topographic map of the arid region is necessary for the Irrigation Survey; that unless it is made the cost of that survey will be increased many fold. This statement it is impossible to comprehend. It is, of course, easy to see that such a map would give useful information of a general kind and would be convenient for many minor purposes. But the engineers, while admitting this, testify with one voice that its usefulness goes no farther; that such a map is not at all necessary in any imperative sense; that it will not save them any important amount of labor or expense; that the engineering surveys would be of the same character and cost the same whether they have the maps or not, and that no use has been made of any topographic map by any of the engineers engaged in the Irrigation Survey, except as a general map of the country.

The Director asserts that the maps will make trial lines unnecessary. The engineers say that trial lines are seldom necessary, and when they are, they are run for the purpose of settling questions upon which a topographic map could not possibly give any information whatever. The Director seems to entertain the idea that it will often be doubtful whether the slopes of a country in the trough of a stream will admit of leading

the water from the river upon the bench land, and that a topographic map will settle such questions at a glance, while without the map the engineer would have to make an expensive survey. The engineers say that such questions can be settled in an hour, or in a day or two, by the simplest inspection. The only doubtful questions are those of the amount and cost of construction, which depend on the character of the ground through which a canal must run; and no map gives any information on that subject.

The Director asserts that the topographers are relied upon by him to discover the reservoir sites, and that they can do it at one-fifth or one-sixth the cost of their discovery by the engineers. The engineers say that in order to perform their duty in any district they must see the whole of it themselves, and that no map can take the place of the knowledge of a district which is gained by actually seeing it. This examination they are compelled to make, and in the course of it no reservoir site can escape detection. Their selection and withdrawal, therefore, can be accomplished without any material addition to the cost of the proper work of the survey as a mere incident of a necessary reconnaissance; while the Director's own estimate of the topographic work alone exceeds the entire cost of the engineering and hydrographic work combined.

The Director asserts that the hydrographic work will be very greatly cheapened by a topographic map showing the areas of water-sheds and their slopes from which the amount of water running off can be computed. The engineers claim that such a computation would be no better than guess work and would lead to no result, and that the only known method of finding the water supply of a drainage basin is to measure it. If guess work is sufficient they can guess as well without the map as with it. It must be remembered that a competent civil engineer is necessarily a good topographer, and understands also the nature of proper hydrographic work. The greater includes the lesser.

ARE TOPOGRAPHICAL MAPS NECESSARY?

The Director contends that the segregation of the irrigable lands can be effected much more cheaply by a topographic survey than in any other manner. This is a statement upon which any member of Congress can form an opinion without any advice from either topographers or engineers. The law vests the administration of the public lands of the United States in the General Land Office. It has for nearly a century provided a system, and grown up under it, by which the public lands are parceled into townships, sections, and quarter sections. The people are thoroughly educated to it and understand it. Surveys have been provided which make the subdivision and mark the corners on the ground, and the law recognizes such marks as the true and only lawful metes and bounds. The Land Office has a record system of all surveyed parcels, and it is the only record which the law recognizes. It has a system of maps or plats which the law makes a part of the official record, and the exemplifications of the plats and records under the seal of the Land Office are competent evidence in the courts.

The Geological Survey has been authorized and required to segregate certain public lands which it may find to be irrigable, but as the law has not taken the administration and record of the public lands from the Land Office, it is claimed that the work of the Geological Survey can go no further in this matter than to indicate to the General Land Office what particular lands it finds to be irrigable, and, there-

fore, subject to withdrawal from occupation, sale, and entry. How are these lands to be specified? Plainly, in such terms as the law provides—by townships, sections, and quarter sections. Upon what maps should they be represented? Plainly, upon such maps as the Land Office is by law authorized to employ. What can the Land Office do with a topographic map? Such a map has no recognition in the law for purposes of record and carries with it no substantive fact of which the Land Office can take the slightest cognizance. That office can not recognize any maps but its own. Probably the Director will admit this. But he asserts that the work of segregation will be greatly cheapened if the topographic map is made.

Now it is plain enough that in order to specify irrigable lands the irrigation engineers must first go over the country to find out what lands are irrigable. He must then identify what townships and sections include these irrigable lands and must identify the corners on the ground. He can then represent them on a transcript of the Land Office map, and report them, section by section, to the Land Office. In case the irrigation survey precedes the Land Office survey, the engineers can connect their work with the Land Office surveys, and this can usually be done by running a single line or by triangulation.

The engineers say that they find some convenience in topographic maps in the way of general information of a geographical character. But they can dispense with them without any serious inconvenience, just as they can dispense with many other things which might be convenient, and they can accomplish their work without them at a cost not materially greater than if they had them.

The maps already in existence furnish sufficient information for the guidance of the engineers. These maps are compiled from various sources. First, the Land Office surveys, which are the basis of all the maps of the public land States. Second, the railroad surveys, which furnish much of the topography of the country. Third, the topographic surveys of Wheeler, Hayden, and Powell. From these various sources the Director of the Geological Survey has already constructed, or rather perfected, maps of the arid region which are very creditable and useful. The committee will print, in connection with the testimony, several of these maps, one showing the arid region, one showing the timber in the arid region, and several maps showing the various drainage basins. It is believed that these maps are all that is required for the engineering work for irrigation.

INDEFENSIBLE USE OF PUBLIC MONEY.

If it be admitted, however, that the views of the Director of the Geological Survey are correct as to the necessity for topographic surveys in advance of irrigation surveys, such views are no justification for the diversion to topography of the money appropriated for irrigation. Congress provided how and for what purpose the money should be applied, and it is the duty of the executive officer to so apply it. He is not employed or empowered to use public money otherwise than is prescribed by law.

The act of March 2, 1889, not only made a separate appropriation for both the topographic and irrigation surveys, but declared that—

The Director of the Geological Survey, under the supervision of the Secretary of the Interior, shall make a report to Congress on the first Monday of December of each year, showing in detail how the said money has been expended, the amount used for actual survey and engineer work in the field in locating sites for reservoirs, and an itemized account of the expenditures under this and any future appropriation.

This language plainly excludes the use of this money for any other purpose than actual engineering work for the purpose of irrigation in the field and the necessary office work connected with the same. No itemized account of the expenditure of this money has been rendered to the knowledge of your committee, but they have the statement of Capt. Clarence E. Dutton, of the U. S. Army, who has had charge of the expenditure of such portions of these two appropriations as were allotted by the Director to irrigation surveys, which statement is printed with this report. (Vol. 4, of the Testimony.)

WITHHOLDING PUBLIC LANDS FROM SETTLEMENT.

A provision was inserted in the act of October 2, 1888, which is working great hardship to the people of all the arid States and Territories. It was necessary to reserve "all the lands which may hereafter be designated or selected by such United States surveys for sites for reservoirs, ditches, or canals for irrigation purposes." This reservation was in the bill as it passed the Senate, and was inserted to prevent the occupation of reservoir sites and other places necessary for public use in connection with irrigation. But the following clause was unnecessary and the construction given to it has been disastrous. It did not come from the original friends of irrigation development. It adds to the provision above quoted the following:

And all the lands made susceptible of irrigation by such reservoirs, ditches, or canals are from this time henceforth hereby reserved from sale, as the property of the United States, and shall not be subject after the passage of this act, to entry, settlement, or occupation until further provided by law: *Provided*, That the President may at any time in his discretion by proclamation open any portion or all of the lands reserved by this provision to settlement under the homestead laws.

Under this clause, reserving lands made susceptible of irrigation by the hydraulic works named, the following order was made by the Commissioner of the General Land Office:

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
Washington, D. C., August 5, 1889.

REGISTERS AND RECEIVERS, *United States Land Offices:*

GENTLEMEN: Information having reached this Department that parties are endeavoring to make filings on arid lands reserved for reservoirs, irrigating ditches, and canals, and for the purpose of controlling the waters of lakes and rivers and their tributaries in the arid regions, I am directed by Hon. Secretary of the Interior to call your special attention to the act of Congress approved October 2, 1888, U. S. Statutes at Large, vol. 25, page 526, as follows:

"For the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation, and the segregation of the irrigable lands in such arid region, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and the prevention of floods and overflows, and to make the necessary maps, including the pay of employees in field and in office, the cost of all instruments, apparatus, and materials, and all other necessary expenses connected therewith, the work to be performed by the Geological Survey, under the direction of the Secretary of the Interior, the sum of one hundred thousand dollars or so much thereof as may be necessary. And the Director of the Geological Survey, under the supervision of the Secretary of the Interior, shall make a report to Congress on the first Monday in December of each year, showing in detail how the said money has been expended, the amount used for actual survey and engineer work in the field in locating sites for reservoirs, and an itemized account of the expenditures under this appropriation. And all the lands which may hereafter be designated or selected by such United States surveys for sites for reservoirs, ditches, or canals for irrigation purposes and all the lands made susceptible of irrigation by such reservoirs, ditches, or canals, are from this time henceforth hereby reserved from sale as the property of the United States, and shall not be subject after

the passage of this act to entry, settlement, or occupation until further provided by law: *Provided*, That the President at any time in his discretion, by proclamation, may open any portion or all of the lands reserved by this provision to settlement under the homestead laws."

The object sought to be accomplished by the foregoing provision is unmistakable. The water sources and the arid lands that may be irrigated by the system of national irrigation are now reserved to be hereafter, when redeemed to agriculture, transferred to the people of the Territories in which they are situated for homesteads. The act of Congress and common justice require that they should be faithfully preserved for these declared purposes.

The statute provides that all lands which may hereafter be designated or selected by the Geological Survey as sites for reservoirs, ditches, or canals for irrigating purposes, and all lands made susceptible of irrigation by such reservoirs, ditches, or canals are since the passage of said act absolutely reserved from sale as property of the United States, and shall not be subject after the passage of the act to entry, settlement, or occupation until further provided by law, or the President, by proclamation, may open said lands to settlement.

Neither individuals nor corporations have a right to make filings upon any lands thus reserved, nor can they be permitted to obtain control of the lakes and streams that are susceptible of uses for irrigating purposes.

You will therefore immediately cancel all filings made since October 2, 1888, on such sites for reservoirs, ditches, or canals for irrigating purposes, and all lands that may be susceptible of irrigation by such reservoirs, ditches, or canals, whether made by individuals or corporations, and you will hereafter receive no filings upon any such lands.

This order you will carry into effect without delay.

Respectfully,

W. M. STONE,
Acting Commissioner.

As the matter now stands no entries can be made of, or titles perfected to, any of the public lands of the United States requiring irrigation subsequent to October 2, 1888. The people residing in two-fifths of the area of the United States, wherein nearly all of the public lands are situated, are, by the construction given to this law, prevented from acquiring title to any public land fit for cultivation, and all settlements and improvements upon such land are suspended until further legislation can be had.

Attention is called to these facts to show the importance of speedy action on Senate bill No. 2104, reported from this committee. It is proper in this connection to state the general features of the bill and the objects designed to be attained by its passage.

PROPOSED RESERVATION OF ALL NATURAL WATERS.

The bill reserves the unappropriated waters of the lakes and rivers on the public lands for such beneficial uses as shall be determined by the States and Territories in which such waters are situated, and places them under the control of the States and Territories, subject only to the paramount authority of the United States. It reserves the right of way for ditches, canals, and other hydraulic works for the use of irrigation, and allows the flowing waters to be diverted from the natural beds of streams upon the arid areas. Access is also reserved over the public land west of the ninety-eighth meridian of west longitude to all natural waters on the public lands for man and domestic animals. It also reserves to the United States the adjudication of all questions and disputes that may arise in relation to the storage, conservation, flowing, and distribution of all natural waters, flowing or standing, located within or passing through the boundaries of two or more States or Territories within the area described. The bill repeals all laws for the sale or other disposition of the lands where irrigation is necessary, except the mineral land law and the homestead law.

Inasmuch as the people were not informed as to the extent of the reservation of lands referred to in the act of October 2, 1888, it will be necessary to amend the bill reported and provide that bona fide claims heretofore made upon irrigable lands shall not be affected by the reservation. There is, however, one difficulty about the matter. The streams in the high altitudes can be easily diverted upon lands that will produce grass for stock in summer and perhaps some of the hardier vegetables, but which are not valuable lands for settlement. Such diversion is a great waste, and deprives the settlements below, where crops can be produced to perfection, of the use of water for that purpose. The committee therefore recommend the following in lieu of the last section of the reported bill:

That so much of the act of October 2, 1888, entitled "An act making appropriations for the sundry civil expenses of the Government for the fiscal year ending June 30, 1889, and for other purposes," as reserves, "all the lands made susceptible of irrigation by the reservoirs, ditches or canals" mentioned in said act, is hereby repealed; so that the reservation in said act shall only include all the land which may, after the passage of said act, have been or may hereafter be designated or selected by United States surveys for sites for reservoirs, ditches, or canals for irrigation purposes. And bona fide claims, made since the passage of said act, to land within the reservation hereby repealed shall not be defeated or affected by said act: *Provided*, That the diversion of water at high altitudes, where all the agricultural crops produced in the same latitude in the valleys below do not mature, shall confer no prior rights to the use of such water as against persons below who appropriate the water to irrigate land more suitable for homestead settlement, unless such diversion shall be approved by the commissioner of irrigation.

A BUREAU OF IRRIGATION AND ITS DUTIES.

The bill also confers power upon the Commissioner of Irrigation to regulate the amount of land which may be taken in a given locality by a homestead settler, not exceeding 160 acres. It further provides that when reservoirs, canals, and other hydraulic works shall have been completed so as to irrigate all the land in a given district, patents may be issued to claimants of the public lands in such district upon compliance with the laws in force at the time the claims were made; and also provides that when an irrigation district is formed in any State or Territory, and the laws of such State or Territory permit the legal voters residing in such district to tax the land of the State and of private individuals for the purpose of constructing such hydraulic works as are for the common benefit of all the irrigable lands in such district, the United States lands therein shall bear the same burdens as are imposed on State lands and the lands of private persons; and that the homestead settlers who take such lands with the irrigation works constructed for their reclamation, shall take them subject to the payment of the same charges as have been paid by private parties for the same purpose; provided that the amount of such taxes shall be approved by the Commissioner of Irrigation, and that the United States shall not in any case be liable for any of such charges.

It further provides that the people of a district situated in two or more States, or in two or more Territories, or in a State and Territory, may have the benefits of the act by the joint action of all the States and Territories in which any portion of the district is situated; or in case any of the States or Territories refuse to join, then the State or Territory in which the larger portion of the irrigable land is situated may perform all the acts necessary to enable the legal voters to reclaim the lands and secure the benefits of the act.

The committee, believing that irrigation pertains to agriculture and not to geology and other subjects under the charge of the Director of the

Geological Survey, and differing from the Director as to the mode of conducting such matters as relate to irrigation, have provided for the transfer of the Irrigation Survey to the Agricultural Department, and the appointment of a Commissioner of Irrigation in that Department.

OBSERVATIONS NEEDED OF CLIMATOLOGY.

The Secretary of Agriculture must deal with the climate, the soil, and the products, and employ a large force to collect and diffuse information with regard to all matters pertaining to the production of crops and the cultivation of vines and fruits. The Agricultural Department is particularly charged with collecting and diffusing information with regard to modes of cultivation and fertilization of the soil. Irrigation is a great fertilizer, and the proper application of water to the soil is a matter of the first importance to farmers. This relates to agriculture and not to geology.

In addition to the purely engineering work connected with irrigation, it is necessary to know approximately the amount of water discharged from each drainage basin, in order to estimate the quantity of land that may be irrigated; and it is also of importance to know the maximum discharge in time of great floods in order to make ample provision in strength of works and extent of waste weirs to avoid accident. This branch of the service is called hydrography, and it is the subject least understood in the arid region. Since it has been determined to transfer the Weather Service Bureau to the Agricultural Department, the employes of that bureau, and the army of volunteer observers connected therewith, can collect without any material additional expense to the Government all the information necessary on this subject. No other department of the Government is prepared to perform this service without an independent corps of observers. In a very short time the employes of the Weather Service Bureau will be able to do all that is required in measuring the streams and observing the climatic conditions with but slight supervision.

The passage of this bill, it is believed, will enable the bona fide settlers and land-owners to develop the arid region by their united efforts. It will give full play to the enterprise of the pioneers of the west. It avoids, as far as possible, Government interference, and frees the Government from the enormous expense which would be involved if the United States should undertake the supervision and control of this vast region as suggested by the Director of the Geological Survey.

It also prevents the delay which would be occasioned by waiting for the expenditure of many millions of dollars in geologic and topographic surveys, and in paleontologic, chemical, and physical researches under the Director of the Geological Survey, and also avoids the embarrassment which would be imposed upon irrigation by charging to it the expenditures made by the Director of the Geological Survey for other purposes.

URGENT NEED OF LEGISLATION PROPOSED.

It is necessary and proper that the Government of the United States should survey its public lands. That has been the policy from the beginning. It is unnecessary in the arid region to survey the mountains and deserts which are not suitable for cultivation, until they are required for some useful purpose, but it is important that the lands required by the people for homes should be speedily surveyed. The first step in such survey, the water sources and supplies being ascertained,

is to locate the reservoir sites for their conservation and the lines of main canals and ditches needed for a proper distribution of the same. Such a survey would segregate the irrigable from other public lands, and enable the Government to dispose of them to settlers without surveying the waste lands for which there is no present demand. The amount of the annual expenditure for these irrigation surveys need not be large, although there is a pressing necessity in many localities for these surveys to enable the people to reclaim the land which they require for settlement. An intelligent direction of such surveys is necessary, and Congress should provide for the same.

The committee has also reported two other bills which pertain to the Great Plains region first described. Inasmuch as underground water is found throughout this region, and in many places where experiments have been made it has been brought to the surface in considerable quantities by artesian wells; and inasmuch as in other places important rivers sink and their waters pass beneath the surface, it is regarded as of the highest importance to ascertain to what extent these plains may be irrigated by artesian wells and by other means of bringing the underflow supply to the surface. To what extent these lands may be brought under cultivation by these means is yet unknown, but it is highly probable that great and beneficial results in the irrigation of these lands may be secured by bringing these waters to the surface.

THE SUBTERRANEAN WATERS OF THE GREAT PLAINS.

The first bill reported from the committee has been incorporated in the urgent deficiency bill and has become a law. It appropriated \$20,000 for the purpose of an immediate examination of these great plains, to collect all the facts for the information of the people, and with a view to ascertain the expediency of making experiments by the Government as to the extent of these underground waters and the practicability of utilizing them.

The other bill reported relating to this section makes an appropriation of \$350,000 for a survey and experimental wells and works in this region. The propriety of making this appropriation will be determined by the report which is to be made about the 1st of July.

If anything can be done to encourage the people of these great plains, it is important that it should be done speedily. There are over a million people in this arid and semi-arid belt who have paid into the Treasury of the United States no less than forty millions of dollars for public lands. These people are in want and are suffering all the hardships resulting from the failure of crops in a new country. They are anxiously looking for relief. Their crops having failed, and being without money, they are unable to prosecute experimental works of irrigation. The Government must demonstrate to them the practicability before they will have courage or can command the means to prosecute the work on any considerable scale. If no considerable relief can be obtained from bringing the underflow water to the surface, a knowledge of that fact will be of immense benefit in turning the attention of the people to some other means of relief.

Undoubtedly, as before stated, much of this land will ultimately be reclaimed from the rivers flowing from the Rocky Mountains, when the proper reservoirs and the requisite canals shall have been constructed. But this involves a larger expenditure than the people can now undertake, and it also involves an uncertainty for want of Government surveys.

There is still another means of irrigation which the people themselves will no doubt adopt to some extent, and that is the storage of the storm-waters in small ponds and lakes. The artesian wells and other methods of bringing the underflow water to the surface is the most speedy way, if it is successful, of obtaining relief, and for that reason the committee have recommended these appropriations.

It will not be necessary to continue appropriations of this character, and probably what is once done will be done for all time, and perhaps the appropriations recommended by the committee may be all that will be necessary.

It may be useful to the Government hereafter to bore some experimental wells in the other States and Territories, but the committee have confined their recommendation to that section of country where the greatest suffering exists, and where the largest number of people now are.

A REVIEW OF THE COMMITTEE'S INVESTIGATION.

The work of inquiry undertaken in accordance with the resolution of the Senate was carefully prepared for during the four months that preceded the meeting at St. Paul, Minn., on the 1st of August of last year. Under the direction of your committee the irrigation engineer and expert assigned to it by the United States Geological Survey, placed himself in communication with the official and other representatives of the people living within the arid regions of the west. Circulars were prepared and addressed to Federal, State, Territorial, and County officials, to chambers of commerce, boards of trade, agricultural and horticultural societies, to the representatives of the Patrons of Husbandry and the Farmers' Alliance, to societies of civil engineers, railroad land irrigation companies, and all others known to be interested in the problem of irrigation and reclamation. The result of this work was made apparent in the representative character of the testimony given before your committee. At the same time that these efforts were being systematically made to secure a full expression of views and information from practical sources and from the communities interested, circular letters were addressed, under the committee's instructions, to the State, War, Interior, and Agricultural Departments, for the purpose of obtaining—

First. Such information as the consular service could secure from countries wherein irrigation is now and has long been practiced.

Second. From the experiences and observation of army officers, public land officials, and Indian agents, such facts as their observation has enabled them to accumulate.

Third. From the observations and studies of the experts and officials of the Department of Agriculture, the deductions and statements they desired to make on soil, climate, products, grasses, forestry, and all data falling within their special fields of work and relating to the arid region.

All these preparations enabled the committee to accomplish its work more fully and systematically than otherwise would have been the case. The committee recognizes fully the interest aroused and activity with which its requests were met.

REPRESENTATIVE CHARACTER OF WITNESSES.

During the progress of the field inquiry, commencing on the 1st of August at St. Paul, Minn., and ending September 19, 1889, at Ogallala, Nebr., your committee held fifty-three sessions, examined three hundred

and eighty-two witnesses, and travelled in all about 14,000 miles. In addition, it has examined fourteen witnesses at the capital and heard testimony for several weeks.

At St. Paul the first session was held in the hall of the chamber of commerce, which was placed at the committee's disposal. On behalf of that body an address of welcome was made by Mr. E. V. Smalley. The witnesses at this session were, all but one, from the Territory of Dakota, and represented the most important agricultural and town interests, including officers of the Farmers' Alliance, of the Black Hills section, the counties of Beadle, La Moure, Spink, Dickey, Grant, Marshall, Douglas, and Minnehaha, portions of what are now the States of North and South Dakota. At the next session held in Sioux Falls, S. Dak., the constitutional convention of that State was found in session. The committee were received by the president of the convention, the mayor, and others; and at the session held, nearly all the convention delegates testified, representing fifteen counties. Sessions were held in the Dakotas on the train, as elsewhere, and many witnesses so examined were found presenting the collective opinions and wishes of their several communities. At Huron, the testimony taken includes the evidence of the president of the State Agricultural College, of the mayor, editors, farmers, engineers, and others, specially selected by a county committee.

En route from Huron the committee visited Redfield, Aberdeen, and Jamestown, examining the famous artesian wells at Huron and the points named, while also taking evidence at Jamestown. At Bismarck, the capital of North Dakota, the constitutional convention of that State, then in session, received the committee. The witnesses examined here were all representative, and included a former governor, many delegates to the convention, and several well-informed business men.

The Northern Pacific Railroad, from Bismarck westward, made arrangements to take the committee over such portions of the region as it was most desirable to see in the daylight. To this road, and others on the journey, the committee was indebted for the opportunity of traveling under conditions enabling it to see the largest areas with the least possible expenditure of time. As a result, much of the magnificent valleys and table-lands of the Yellowstone, Gallatin, Columbia, and Snake Basins, in the Northwest, were passed over during daylight, affording to your committee needed object-lessons in the physical facts relating to the reclamation of such region.

TESTIMONY IN THE NORTHWEST.

The progress of the inquiry through Montana was marked by the same interest as was seen in the Dakotas, though it easily intensified as the sections practicing irrigation were reached. At Glendive the board of trade met your committee. The witnesses here were selected by them as representative men. At Billings the town and county officials received us, and a very interesting session was held. Miles City, county seat of Custer, and near to it the United States post of Fort Keogh, was the scene of the most important session of the Yellowstone Valley section. Army officers, Federal officials, county and town officers met the committee at the depot, escorting it to the board of trade rooms. An exhibit of irrigation-grown grains and grasses was made, a map and official report of the county filed with the committee, and other valuable testimony was taken, as will be seen by the printed evidence. Bozeman, center of a large and well cultivated area, was reached after

Billings. After a ride through the valley, examining the irrigated farms, the committee held a session in the town. The witnesses were all practical men.

The next and most important session in Montana was held at Helena. The committee was received by the Territorial and city officials, as well as by the constitutional convention then in session. The testimony taken here includes a careful report of the State, prepared by Colonel De Lacey, civil engineer, for the Montana Society of Civil Engineers. The late surveyor-general, Mr. Greene, was a valuable witness. Among others before the committee were the Hons. Wilbur F. Sanders, Martin Maginnis, and W. A. Burleigh, Judge Hiram Knowles, Mining Inspector G. C. Swallow, and Civil Engineer William F. Wheeler. The testimony given will repay critical examination. Following the Helena session, after some examination of the region, the committee proceeded to Missoula. Attention is called to the testimony of Mr. H. M. Wilson, division civil engineer United States Irrigation Survey, as illustrating intelligently the character of its work. Missoula, the chief town of Bitter Root Valley, noted as the fruit section of Montana, was the seat of an interesting session, at which county officers, surveyors, and farmers testified.

Passing westward into Washington the committee found an interesting field in the eastern or subarid section of the new State. The examination of the Moxie farm, near North Yakima, as well as the session held thereon and afterwards in the chamber of commerce at North Yakima, offers abundant proof of the needs and advantages of irrigation, and of the great area that can be reclaimed therein. Ellensburg, further west, where a brief session and field examination was made, showed by positive demonstration in its fertile and extensive irrigated fields the value of efforts for reclamation. The testimony of the secretary of the local board of trade will be found to be of value. At Walla Walla, further south, but still in eastern Washington, the committee was received by the city officers and the board of trade. The testimony taken here is regional in scope, and gives an excellent idea of conditions, climatic and topographic, in their relations to agriculture and horticulture, while showing the imperative need of water storage in order to make secure such cultivation. This evidence and demand was strongly supported by witnesses whose testimony was taken on the train at The Dalles and Baker City, Oreg., and at Palmer, Idaho.

The very important session held on the 17th of August at Boise City, the capital of Idaho Territory, was characterized by a thoroughness of preparation, and the careful presentation of information, which deserves and commands from the committee a full recognition. The great value of the mass of testimony, written and oral, taken at Boise City, is due to the fact that it was made to embrace every county in the Territory, and every phase they offer in considering the problems of reclamation. The committee was officially received on the train by Governor Shoup, Surveyor-General Straughan, and by other officers of the Territory, county, and city. All the formal honors of such a reception were duly tendered. In response to the circular letters sent from Washington, under the committee's direction, the governor and United States surveyor-general had prepared and sent out other circulars, calling forth from the county surveyors and others a series of valuable local reports. Mr. Straughan had caused these to be carefully systematized and compiled uniformly, and, with maps of each county, bound them in a handsome manner for the committee's use.

The evidence taken included that of the surveyor-general, the Dele-

gate in Congress, ex-Governor Stevenson, Division Engineer A. D. Foote, United States Irrigation Survey, and a large number of other representative witnesses. A striking exhibit of fruits and vegetables was made in the council chamber of the capitol of Idaho, in which the session was held. The testimony in relation to Idaho demands careful consideration. The Boisé City session concluded the committee's work in the Northwest proper, which it will be seen includes, as to testimony, South and North Dakota, Montana, eastern sections of Washington and Oregon, and the Territory of Idaho. Eighteen days were occupied in the journey, and during that time one hundred and fifty-eight witnesses were examined, and forty-two other papers received, examined, and filed. The amount of travel alone was sufficiently fatiguing, but when the work of examination is also considered the labor required therein as afterwards will be indeed accounted as arduous.

The trip through the great valley of the Snake River, with its extensive lava beds and the magnificent American and Shoshone Falls, illustrating the volume of water for storage to be had and the engineering difficulties arising as to the means of distribution, followed, after leaving the Oregon Short Line road and entering northern Utah, by the noble landscape presented in the Bear Lake Basin, with its valley, table-lands, foot-hills, and mountains, in which could be seen the evidence of what irrigation produces in the farms and fields of the Mormon settlers, proved to be one of the most interesting experiences of the committee's tour. Recalling the fact that the farmers of Utah are members of the first English-speaking community that has practiced irrigation, observation of their work and its results became a matter of grave interest. Irrigation began in Utah with the first Mormon hegira very early in the fifties, and within its range that Territory offers the most valuable of all evidence as to what follows the redemption by irrigation of our arid region.

WITNESSES IN SALT LAKE AND NEVADA.

The sessions held in Salt Lake City on the 19th and 20th of August prove the value of the preparations that had been made. Governor A. L. Thomas, in response to the communications sent by the committee's expert and engineer, had made an elaborate effort to secure complete data. Under his energetic direction the taking of testimony had been systematically provided for. Officers of the United States Geological Survey, with the Director thereof, Maj. John W. Powell, also gave valuable aid. Director Powell accompanied the committee (meeting it at St. Paul and Bismarck) throughout the entire journey. Governor Thomas presented, through Prof. Marcus E. Jones, of the Deseret University, an elaborate report of the Territory, embracing every county, giving their water sources and supply, rain-fall and other precipitations, areas irrigated or reclaimable, facilities for storage, extent of irrigation ditches, dams, and other works, wells (artesian or otherwise), products raised, laws and customs governing duty of water, method of ditch ownership, natural lakes, rivers, and other streams or water supply, with estimates of what may be done with larger facilities. The witnesses testifying include the governor, secretary of the chamber of commerce, the probate judges, surveyors, and commissioners of many counties, local farmers, engineers, railroad men, and others—all representative in character. Elaborate maps were filed with the county reports, and though no other sessions were held in Salt Lake City, yet full statements from all parts of the Territory were brought before the committee.

The evidence taken at Salt Lake City relative to the results of irrigation among a peculiar community and amid conditions as severe for reclamation purposes as any in the West, deserves the most careful review. It is especially interesting in its relations to the smallness of the areas under cultivation, their minute subdivision and power to support the cultivators, as well as the method of water control, distribution and the using of the same. In no part of our arid region has the use of irrigation in agriculture presented more striking facts or within the lines upon which the local problems operate more satisfactory results. The Utah session was attended by fifteen witnesses. In addition there were filed with the committee one general report, eighteen county and four local reports, and two other special papers, all of them full of important data.

The examination of the Basin region was continued in the taking of evidence at Carson City, Nev. The committee was received by the State officers, who placed the supreme court room in the capitol at its disposal. Nevada presents the gravest of needs and the largest of possible areas in its relation to reclamation by means of water storage and irrigation. The State is thoroughly aroused to its own needs and the methods required to meet them. At the last session of the State legislature it was formed into districts for storage purposes, and a State board appointed. An efficient State weather service has been in operation since 1887. The testimony presented to the committee had been prepared for in advance by the exertions of the State surveyor-general and the board of reclamation in response to circulars and other requests of your committee. In addition to the report and maps prepared by the State board, the witnesses include representatives from the several counties.

The conditions of reclamation in Nevada demand serious consideration. It will be then found that with a fitting system of water storage and irrigation distribution this mountain State, instead of presenting reasons for gloom or despair, offers a bright prospect and a fair future of material prosperity. The Nevada witnesses, nineteen in number, include the secretary of the State board of reclamation and internal improvement, the United States surveyor-general, chief of the State weather service, county officers, with reports from different parts of the State.

Leaving the interior or basin sections of the arid West the committee held its next session in the city of San Francisco. It is necessary to say, in passing, that much work was done outside the taking of testimony in order to obtain a more complete understanding by the members of your committee of the conditions involved in the inquiry it had undertaken. Among other journeys was one by stage and boat to and across Lake Tahoe and by coach again through the valley of the Truckee to the railroad at Truckee. This enabled the committee to understand the hydrographic and other physical features of the great drainage and mountain lake areas, which are necessarily related to any plans of reclamation in western Nevada and eastern California. It was but one of several observation trips that formed part of the committee's general work, but the result of which can not be presented in the testimony submitted.

ON THE PACIFIC COAST.

The California State Board of Trade having undertaken in a comprehensive manner the work of replying to the committee's requests for information, it was proper that the sessions in San Francisco should be

held in the rooms it had so courteously tendered. They were truly representative in character. A valuable State report was first submitted by the Hon. M. M. Estee, chairman of the board, which embraces the main features and facts in relation to reclamation and water storage, as well as the date of irrigation already accomplished. The witnesses called by the State Board of Trade were fifteen in number, and included, among others, William H. Hall, formerly State engineer, and now supervising civil engineer of the Pacific slope in the United States Irrigation Survey; W. S. Green, a well-known editor of northern California; George Manuel, a prominent civil and irrigation engineer of the San Joaquin Valley, resident at Fresno; Bernhard Mark, a successful organizer of horticultural land colonies; Dr. Perrin, a large landowner, extensively identified with irrigation colony enterprises; L. M. Holt, one of the earliest settlers and organizers of the famous colony of Riverside; Hon. N. P. Chipman (formerly Delegate in Congress from the District of Columbia), of northern California; Dr. Hilgard, of the University of California, an eminent scientific authority on all matters relating to agriculture, horticulture, climatology, etc., and ex-State Senator C. C. Wright, the author of the code of State laws known as the "Irrigation District System."

By these laws in the first place the just principle of prior appropriation, governed and limited as to beneficial and actual use, is applied to and placed under the control of the community to be benefited, and through which in the second place any given irrigation community, by becoming under the said laws a body corporate, can issue bonds and make contracts for needed works, establish rates, and hold liens on all the lands benefited for the payment of interest and principal. These laws leave to the local communities affected the use of the natural waters within them for beneficial servitudes only, enable them to construct, own, and control the works needed for water storage and distribution, and give the means of obtaining a credit for that purpose, which, when capital understands the security it offers, will assuredly command all the money that may be needed.

The San Francisco session was one of the most satisfactory held. Added to the testimony directly given, there will be found a valuable State report, a summary of an important paper on alkali soils and well-water supplies by Professor Hilgard, and useful statements by other citizens. The committee then proceeded southward, stopping en route at Merced and Fresno, in the San Joaquin Valley, to examine the results of irrigation at those places. Fresno was especially interesting as the center of an increasing land colonization system, which has, by irrigation and small farm holdings, already reclaimed an area of over 100,000 acres, on which a population of at least 26,000 persons are supported in independence and comfort. That is an area of less than 4 acres to each person. The land now "under water" in this immediate region is about 250,000 acres, and there is every prospect of the early cultivation of that entire area. The chief products are raisin grapes and others for table use and wine-making.

The next session was held at Tulare, at which nine persons testified. A large display of fruits, vegetables, and grain, grown under irrigation, was made. This session's testimony illustrates the success of co-operative endeavor and intensive farming, with irrigation, as carried out by men of small means, but energy and industry.

The session at Bakersfield, Kern County, was preceded on the committee's and Director Powell's part by a journey of observation of some 60 miles, covering the main features of the extensive system of irriga-

tion works and fields constructed and worked by Messrs. Haggin and Carr. In this way valuable object lessons were obtained as to the possibilities of reclamation, covering alfalfa, grain, root, and fruit crops, as well as the raising of valuable stock. Kern County embraces, as the evidence and reports given will show, not only the most extensive single system of irrigation works owned and constructed by one firm within the United States, but other and most essential features of arid land reclamation.

There are still considerable areas supplied by the small ditches of individual or combined farmers, besides a section in which the supply of artesian water is large and the number of wells very notable. The Bakersfield testimony covers the views of resident farmers and a comprehensive and valuable report from William B. Carr, one of the owners of the Kern County canals. In it will be found statistics of cost, production, areas covered and cultivated, mileage of canals, and all other facts necessary for obtaining a fair understanding of the nature, extent, and cost of such an enterprise. Among the papers relating to irrigation added at the close of the California division will be found one of interest relating specially to Kern County and to the general question of legal control over natural water.

The remaining sessions in California were held at Los Angeles, September 1; on the train, near San Bernardino and Riverside, and at Riverside on the 2d; in the evening of the same day at Santa Ana, and at San Diego on the 3d; returning the same night to San Bernardino, and thence southward across the Colorado Desert, arriving at Yuma, Ariz., soon after sunrise on the morning of the 4th of September, where a session was held on the piazza of the hotel, surrounded by a fine example of tropical fruits grown in the gardens of the neighborhood. Twenty-eight important witnesses were examined orally at the southern California sessions. Among them were the most representative viticulturists and horticulturists, irrigation and civil engineers, organizers of successful fruit-growing colonies, and prominent business men. At all the points named the committee were received by the local chamber of commerce and the civic or county officials. At Los Angeles, San Bernardino, and San Diego, especially, were the courtesies and efforts to place correct testimony in the committee's possession more marked. At all points valuable maps and other exhibits were filed with the engineer expert who accompanied the committee.

EVIDENCE TAKEN IN ARIZONA.

The first session in Arizona, held at Yuma, was attended by a county committee, who presented an elaborate and carefully prepared report with maps. The ability displayed in this report, as well as in the testimony given, showed the talent and interest now being centered in connection with irrigation enterprises and their development in sections heretofore esteemed most unpromising. The lower valley of the Gila River is clearly shown to be a most promising field for semi-tropical fruits, sugar cane, and cotton. Rice too, it is claimed, may be profitably raised in the overflowed region below Yuma, now forming the head of the Gulf of California.

The committee passed from its session in the early morning of September 4 over the Southern Pacific Railroad for 156 miles to the north. The capital of Arizona was reached during the afternoon and a session held immediately on our arrival. As at Yuma, and afterward at Tucson, the witnesses at Phoenix were heard in the open air. Governor Wolfley, with the leading Territorial and county officers, were in attend-

ance, and the session was made especially interesting by the intelligent engineers and others connected with the irrigation corporation operating in Salt River Valley. Reports were filed with the committee from the counties of Mariposa, Yavapai, and Apache, as well as a general one for the Territory, prepared by Mr. Farish, commissioner of emigration. Reports were also received from the engineer of the Walnut Creek storage reservoir, the dam of which has since bursted, causing a great loss of life. Lieutenant Glasford, U. S. Army, of the Signal Service, also filed a very interesting and useful report on the climatology of the Territory. En route to Tucson, on the 5th of September the committee took testimony on the train in relation to Pinal County and to a proposed and important storage basin at the Buttes on the Gila River, some miles above Florence.

Tucson was reached early in the day and a session convened at once. The committee were met by the officials of the city and county and by a committee appointed to make a report for southern Arizona. Reports for Pima, Graham and Cochise Counties were filed, and one also of an engineering project for a series of reservoirs and dams at Pantado, near Tucson. The witnesses orally examined in Arizona were twenty-four in number and in addition seventeen valuable reports were received and filed.

INTERNATIONAL QUESTIONS AT EL PASO.

Passing direct to El Paso, Tex., the committee were met by the city authorities, by the county officers, a representative of the governor of Texas, representatives of the land department of the Texas Pacific Railway, the governor of New Mexico with members of his staff, and also by representatives of the Mexican city of Juarez, and an engineer officer of that Republic. A committee of citizens had been preparing in advance for the session, and the city hall council room was placed at its disposal.

The problem under consideration at this point is a serious one, involving international complications, as well as others, injuriously affecting the prosperity of our own people inhabiting two-thirds of the 1,200 linear miles through which runs the Rio Grande River. That river has its rise in the lofty San Juan, Sagauche, and Snowy ranges, that form the western and northwestern run of the great San Luis Park or valley in southern Colorado. The rapid increase of irrigation works, and they, too, on a large scale, within that valley bids fair to absorb at an early day nearly or quite all of the waters in sight that through its upper channels flow down to and across the wonderful mountain bowl of San Luis and from the Rio Grande River and Valley. After crossing the great basin plain, almost diagonally, it turns southward and entering New Mexico passes through the Taos Cañon section, debouching again into the open valley at Embudo, to the north of Santa Fé. From that point to the deep cañons below Presidio del Norte, in Texas, the river for about 500 miles has run almost or entirely dry during the past year. There has been a growing scarcity of water for several years. Colorado and northern New Mexico have necessarily absorbed the major portion, yet below them are found Mexican and Pueblo Indian communities claiming water rights that have been theirs for centuries—rights which are guarantied to them by treaty and convention entered into and ratified by the United States and Mexico.

The long-established privileges in the natural waters and their use for beneficial purposes by at least 100,000 citizens and inhabitants of our own territory were found by the committee to be in peril by the almost complete absorption of the running waters from the upper portions of

the Rio Grande. But this is by no means the most embarrassing part of the situation. The same deprivation most seriously affects the Mexican people resident at Juarez (Paso del Norte) and along the western side of the Rio Grande Valley in northeast Chihuahua, one of the northern States of the Republic of Mexico. El Paso, Tex., our principal port of entry for Mexico, is faced on the other and Mexican side of the river by the growing city of Juarez. There are at least 30,000 persons in and directly connected with these two cities and the immediate valley wherein they are located. The water famine and the uncertainty of the river channel—for the stream, when present, runs over a sandy and friable bed and bottom land for at least 2 miles in width—involves constant troubles and often threatens disturbing collisions, both as to the boundary line of the two countries and the actual and imperatively needed water supply required for general purposes.

The United States Irrigation Survey had been for some months before the committee's arrival engaged in making the necessary locations, surveys, plans, and estimates for the establishment of a dam and reservoir at a point just above El Paso for the purpose of storing therein the storm and surplus waters as well as the natural drainage of the cañon region wherein the proposed works are to be situated and constructed. Maj. Anson Mill, Tenth Cavalry, U. S. Army, a competent civil engineer, was, under the supervision of Director Powell, U. S. Geological Survey, in charge of this preliminary work. By direction of the Mexican President one of its official engineers, Señor Garfias, was co-operating with Major Mill and the other engineers and attachés of the United States Irrigation Survey. The irrigation situation was and is as immediately pressing to the Mexican people as the international questions might prove at any moment to the two Governments. These were the conditions that made the El Paso session perhaps the most important of any held by your committee.

The persons testifying included the mayors of both El Paso and Juarez; Engineer Garfias, the Mexican consul at Juarez; a committee of citizens who had prepared reports to offer, and several gentlemen long familiar with the laws, customs, and conditions affecting the questions at issue. Major Mill and his assistants, with maps, were present and amply elucidated their plans, while Director Powell reviewed the nature of the several hydrographic basins into which the great valley of the Rio Grande is physically divided. The whole session was one of marked interest, and the testimony and papers presented should be carefully studied. The utmost courtesies were extended your committee by the Mexican as well as the Texan authorities. Considerable field observation was made.

WHAT WAS SAID ABOUT WESTERN TEXAS.

At the El Paso session, beside the international dam project, evidence was presented by the State geologist of Texas and Mr. Roesler of Dallas, in relation to the needs and possibilities of irrigation in that State, and by Mr. Bronson, of El Paso, in regard to the irrigation of the Pecos Valley, in southeastern New Mexico. It was shown, at sessions on the train while crossing the Staked Plains and at a session held in Fort Worth, that a considerable area of Texas requires the conservation and restoration of natural waters, both by storage of surplus and storm waters and by the restoration to the surface of those found beneath it, in order that the security of both agricultural and pastoral pursuits may be attained. The entire southwest section from El Paso

downward to the Gulf, including the eastern half of the lower Rio Grande drainage-basin, as well as the minor but very important basins of the Pecos and Colorado Rivers, a distance at its broadest part of 6 degrees of longitude, requires irrigation in order to make possible the industries by which it alone can be reclaimed. For 3 degrees of longitude farther east the storage of water for use in the critical period just preceding harvest will also be found a necessity.

But northwestern Texas, like the central portions of both the Dakotas, presents an interesting series of problems for the geologist and engineer, as well as of encouragement for the practical farmer and settler seeking homes on the soil. These problems relate to the under-ground water supply, which in the Dakotas form the magnificent belt of artesian wells that make that region so remarkable, and on the Staked Plains and Pan Handle sections of Texas furnish, from what are believed by many competent observers to be subterranean streams, finding their way through under-ground channels and by steady pressure in given directions percolating through the resisting strata, a water supply for numerous wells which has already proven of considerable service, and which it is claimed can, at a comparatively small cost, be so explored, defined, and delimited as to be made of great value to the region and its residents. This region is also, as to the northwestern and western portions, one of remarkable springs that rise with great volume and force. In this respect, the evidence includes eastern New Mexico, and there is reason to believe that it will be found as to both wells and springs to extend over the extreme western portion of the Indian Territory into southwestern Kansas. In any event, the evidence presented at El Paso and Fort Worth, Tex., and elsewhere, is of great interest and importance.

TEXAS STAKED PLAINS AND NEW MEXICO.

At El Paso, Governor Prince, of New Mexico, with a committee of delegates from the constitutional convention, then in session at Santa Fé, met the committee to urge the importance of a session in that Territory. The committee proceeded to Santa Fé, where the party was met by the officials and courteously welcomed. The presence at Santa Fé of delegates from all the counties gave an excellent opportunity of obtaining a very complete summary of the water conditions and irrigation needs of New Mexico. The threatened destruction of water rights and farms, established and cultivated for many generations, by reason of the absorption in southern Colorado of the flow of the Rio Grande River, brings into grave importance interstate or interterritorial conditions and jurisdictions upon the rightful relations of which depends so much of the future well-being of the communities interested. The Santa Fé session proved, therefore, to be of value.

On the committee's return to El Paso a short session was held at Las Cruces, in the Mesilla Valley, Dona Ana County, the finest fruit region in the Territory, and a rapid drive over the valley was also taken. From El Paso the committee proceeded east to Fort Worth, Tex., taking testimony, as already referred to, and then proceeded northward to the valley of the Arkansas in southwestern Kansas. In passing from Texas the committee refers with thanks to the mass of the testimony taken and forwarded from the Pan Handle and Staked Plains counties in that State. This was obtained through the unremunerated exertions of Mr. F. E. Roesler, of Dallas, whose exertions for the public good deserve this acknowledgment, at least.

IN SOUTHWEST KANSAS.

Turning westward once more the committee held sessions at Kinsley, Dodge City and Garden City, Kans. It heard in that part of Kansas over thirty witnesses, representing by appointment every farming locality affected by the drought and, therefore, interested in the question of an industrial water supply. The interstate water question is certainly a live one for the farmers of southwest Kansas. The Arkansas River had given so indifferent a supply during the year that 300 miles out of the 500 miles of irrigation ditches constructed in Kansas east of the Colorado line were unsupplied with water and, therefore, were practically useless. The natural waters of Colorado are, by its constitution, State property, and by its law are all consumable within the State itself. As with the Rio Grande, so it is with the Arkansas. As it emerges from its sources and cañon channels within the Rockies, the absorption of its surface flow commences with the foot-hills wherever an available area is found for cultivation, until above Pueblo it debouches into the Plains section and flows eastward across Bent County. By the time it reaches the eastern line there is little or no water left to flow below, during the dry season at least. Percolation follows, of course, and in the course of time, as the irrigation engineers claim, the waters spread upon and absorbed by the soil return in large part to the channel below where irrigation is practiced. But even if this return seepage be as large in quantity as asserted, its gathering flow is necessarily slow and must in any event be attainable only after the occasion. In other words, it can not be utilized when wanted—the season of irrigation.

The sessions at Dodge and Garden Cities were notable for the bringing out boldly of a suggestive theory, which, if practical experiments tend to establish the truth of, will surely prove productive of great benefit, not only to the section under consideration, but many other portions of the arid region. The proposition involved is that a large proportion of the water flow of the Arkansas River, which at flood time is very great in volume, is lost by means of seepage. The valley bed is wide, the stream itself broad and shallow, the grade from the mountains eastward is at least 7 feet to the mile, giving a rapid descent, adding thereby to the surface loss, and the soil of the whole valley with the stratum beneath is composed of loose friable matter, with sand and gravel below in which the percolated waters are readily absorbed and held, while the impermeable clays beneath keep the current from passing to greater depths.

It was urged in the Kansas sessions, especially that at Garden City, that the "underflow," as it is termed, can be reached through very simple engineering, owing to the regular descent alluded to, by means of tunnels driven in the alleged seepage drift and from these drawn into reservoirs to the surface at proper levels and thence distributed over the thirsty areas for several miles miles north and south on either side of the river. The assistance of the Government is asked to demonstrate by experimental work the correctness of this theory or suggestion. Private enterprise has at or near Dodge City already started underflow works, and it is asserted with a remarkable degree of success. It is assumed, however, that no extensive works can be carried on for southwestern Kansas reclamation without entering and drifting into the river bed within the State of Colorado. The projectors are met, therefore, at the outset with the fear of opposing State jurisdiction.

COLORADO, WYOMING, AND NEBRASKA.

Entering Colorado the committee held sessions therein at Pueblo, Colorado Springs, Denver, Fort Collins, and Greeley, thus obtaining data and information from the principal points concerned in the State which, by its active enterprise, as well as the legislation on the subject of water uses, has placed itself with California as foremost in the work of intensive agriculture by means of irrigation. The sessions at Pueblo and Colorado Springs proved interesting because of the local facts obtained at the first place in regard to the Arkansas, and as to forestry matters in the State at the second point. At Denver the chamber of commerce was opened for the committee's use, and the testimony presented at the sessions held therein will be found among the most valuable of the investigation. The presence here of the supervising engineer for the Rocky Mountains of the United States Irrigation (formerly State engineer of Colorado), with that of the State engineer also, and of other civil engineers, who had all interested themselves in arranging the evidence taken, resulted in bringing before the committee a peculiarly representative mass of testimony.

Examination will show all phases of irrigation as seen in Colorado: field works, storage possibilities, the duty and economy of water, cost of construction and administration, areas covered and cultivated, percolation, seepage, volume, gauging of water, the legal questions involved, advantages of irrigation, increase in products and land values, character of water service, legislation to secure and conserve the same, with the nature and tendency of popular complaint and agitation; these and other issues were all brought out clearly by the intelligent gentlemen who presented their views at the Denver session. Among such witnesses were found, besides the engineers, members of the bar, judges of the courts, farmers of experience, business men of importance, two of the former governors, organizers of irrigation enterprises, and leaders in agricultural societies and associations. The utmost interest was manifested by the press of Denver, and in fact by the whole people of Colorado, whose public men and representatives were eager in aiding your committee's investigation.

From Denver the committee proceeded northward to Cheyenne, Wyo., stopping to take testimony at Fort Collins (at which point the State Agricultural College is located), and at Greeley, seat of our first successful irrigation colony, and the center of a very prosperous agricultural community, the result solely of the systematic application of water to the land by means of ditches. The evidence of ex-Governor Eaton, one of the earliest associates in the Greeley colony, though not one of its original organizers, should be read with care.

At Cheyenne the committee was again most fortunate in finding gathered at this point, the Territorial capital, the members of a constitutional convention engaged in the work of State-making. In conjunction with Governor Warren, Territorial Engineer Elwood Meade, and a number of representative citizens, the delegates gave to your committee a mass of information which shows the present and possible irrigation works and probabilities of Wyoming in a most comprehensive light. This progressive community has modeled its water laws and regulations upon the system pursued in Colorado. In so doing, Wyoming has certainly started right. A series of valuable reports, carefully prepared in advance by Engineer Meade, were filed with the committee, accompanied also with maps. Wyoming, like Kansas, New

Mexico, and Nebraska, is agitated by the problems of interstate waters, their flow and use.

Professor Hicks, of the State agricultural experiment station, Lincoln, Nebr., was present at Cheyenne and urged upon the committee the importance of one or more sessions in that State. A subcommittee, with the Director of the Geological Survey, the engineer expert assigned to the committee and the other officers visited Ogallala, Nebr., accompanied by Professor Hicks. This, the closing field session, proved one of the most significant. Great interest was manifested by the citizens, and witnesses were present from various portions of western Nebraska. An especial feature was the account given of the irrigation enterprise at North Platte, the most easterly of all such projects known to your committee.

In closing this portion of the review of your committee's extended and quite exhaustive field inquiry, it is not improper to recur again to the remarkably representative nature of the testimony taken, and of the deep interest the investigation everywhere aroused. If the committee had had the leisure and strength to have extended its labors and the field of inquiry, the requests that poured in upon it from all sides would have required many weeks to have met, and yet would have been time well expended. The wide reach, yet accurate nature of the facts gathered in the testimony presented with this report, will give thereto a growing value. If nothing else resulted than the presentation of this testimony for the use of the Senate and of the American people, the committee's investigation would be of value sufficient to fully warrant the labor and cost it has required.

CLIMATIC CONDITIONS OF THE TWO DAKOTAS.

The evidence taken at St. Paul and at various points in South and North Dakota, revealed climatic conditions that were a surprise even to the members present of your committee. It had been accepted almost as unquestioned that the Dakotas were among the most secure and most advanced in agricultural prosperity of all our western communities. That they are being populated rapidly under advanced circumstances as to pioneer life is most certainly true. The handsome towns and cities, the large railroad facilities already had, the neat dwellings and well-cared-for farms everywhere seen along their routes; the generally young, but always energetic and hardy population that was encountered; all these spoke volumes in favor of both the Dakotas; yet it is a simple fact that a large portion of these two new States, lies within the subhumid and arid areas of the United States.

The conditions of the last five years, culminating in the drought of the past year, have established to the minds of the most intelligent and sanguine of citizens in that part of these States, the conviction that without in some considerable degree obtaining artificial supply of water for agricultural purposes, farming will remain a very uncertain pursuit, and that, therefore, the general prosperity of the two States will be liable to be severely affected. The Dakotas, North and South, lie almost wholly west of the ninety-seventh degree of longitude from Greenwich. East and west it embraces 7 degrees, that of 104° being its westerly boundaries; degrees 98 and 99 are conceded to be within the subarid or subhumid belt, comprising from north to south what has been termed the Great Plains. The remaining 4 degrees are within the arid region proper, that of 100° of west longitude being accepted as the eastern limits thereof. The average rain-fall for seven years in South

Dakota—that is of nine stations, a majority of which are east of the Missouri—is 22.98 inches per annum. The summer season rain-fall is estimated at 15 inches; yet, it is shown to be wholly inadequate because of inequality of distribution as to time and place. Instead of rain when needed, the farmer is always in dread of hot winds, blasting the grain as it grows heavy for harvest.

Settlement began about 1875, and increased rapidly from 1880 until the new States were admitted into the Union, each with a population exceeding on admission that of any of the western commonwealths that have preceded them. From 1883, however, the insecurity of farming has been steadily and painfully made apparent. It was the consensus of opinion among all Dakota witnesses that the loss, owing to the drought of last year, as to wheat crop alone was not less than \$20,000,000. Very naturally, if not quite logically, these people, possessed with the knowledge that they have paid into the Treasury for public lands alone over \$20,000,000, are outspoken in asking some aid from the General Government in the way of at least instructing themselves and those who may join them hereafter as to the reasonable probabilities and possibilities of securing and storing a water supply sufficient to serve them in their summer needs.

The entire areas of the two Dakota States is 96,596,480 acres. Of this total at least 50,000,000 acres may be considered as within the arid region, having annual rain-fall of not to exceed 15 inches. North Dakota will average about 18 inches of precipitation per annum. At Fort Meade five years' observation gives 16.59 inches. At Bismarck, the capital of that State, the annual average is placed at 19.50 inches; at Fort Totten it is but 9.6; in the Red River Valley it will be about 22 inches. The Missouri River bisects the two States by the northwest and southeast, passing through three degrees of longitude and then turning almost directly east. West of that river there is little reason to expect that any system of reclamation will be of avail other than by storage reservoirs, running streams, and a large system of main canals and distributories, taking water from the Missouri River as far north as the forty-sixth degree of latitude and conducting it southward, using the numerous tributaries of the basin as both contributory and distributing agents, until the system, thus reenforced from hydrographic basin to basin, may be carried southward far enough to serve western Nebraska and Kansas, as well probably as portions of eastern Wyoming and Colorado.

THEIR WONDERFUL ARTESIAN BELT.

But it is in its remarkable basin or basins of artesian water that the Dakotas, especially South Dakota, are most to be considered in relation to agricultural security and as possibly a permanent relief at least from partial aridity. This is the general opinion of its people, as expressed through the witnesses and reports heard by your committee. An examination of the evidence will show that there are other sources of storage and distribution that experience will show to be equally reliable and, it may be, of more extended value. The central and northeastern section of South Dakota, and the central portion of North Dakota present a large area of shallow lakes and lagoons which an accurate survey will probably show to be available, with proper engineering work, as a series of small reservoirs or drainage storage basins. The narrow streams or rivers which are characteristic of the whole area are apparently eroding their way still deeper. This is a feature of the majority of such bodies of run-

ning waters. Their currents are sluggish, the fall being but slight except towards their sources, while that of the Missouri is large. These streams will have to be stored and diverted from their natural channels into high-line canals for agricultural distribution. The low range of hills, known as "the Coteaux," lying on the east side of the great river afford, also, opportunities for local storage basins, all of which may yet be utilized.

The artesian belt of the James River Valley, or rather of its entire hydrographic basin, is the largest water body of its character known to the world. The James River takes its rise in the Devil's Lake basin and runs for over 400 miles almost due southward until it enters the Missouri River at Yankton, where the artesian belt has so far reached its largest development. The area thus embraced is at least 50 miles in average width. It contains about 7,000,000 acres, of which certainly 98 per cent. could be made available for tillage. From Jamestown, N. Dak., about 50 miles above the northern line of South Dakota, to Yankton, in the extreme southern part of the same State, there are now about 50 artesian town wells in operation, striking water at a depth that ranges from 1,576 feet at Jamestown to 610 and 600 at Yankton and Frankfort. There are in all nearly or quite one hundred flowing wells in South Dakota, though all but those named as town wells are usually of small bore and were sunk for farm purposes only. The remarkable features of this belt of artesian water are its quantity, force, and continuance. The pressure of the principal wells is from 25 pounds to the square foot at Highmore to 170 at Yankton, where five wells supply the town with water for domestic uses, town purposes, and as power for manufacturing.

A considerable number of artesian wells for farm uses are found in the same county. Aberdeen has two, Jamestown, Huron, Redfield, and other places one each, which furnish water enough, in volume and force, to supersede all other water-works, and to run flour and other mills and factories. The flow of water ranges per minute from 4,000 gallons at Columbia, 3,500 at Aberdeen, 1,500 at Yankton, down to 14 at Highmore. The cost of sinking such wells ranges from \$2,800 to \$7,300. If the business were systematized the cost may probably be not over \$1,500 each. The altitude ranges from 1,906 at Yankton to 1,000 feet above sea-level at Grafton. There are in all eight or ten town wells in North Dakota, of which two flow brackish water. The valley of the Red River, in the north and eastern portion of the States, is blessed with an abundance of water, obtained by wells sunk to very moderate depths in which the supply invariably rises very nearly to the surface. The extent of the Dakota well basin is as yet unknown. Its amount or volume is evidently quite large. The facts given tend to prove that the flow increases, not diminishes, as is generally feared of artesian belts.

Discussion exists, of course, as to the sources of this water. Opinions largely concurred in the belief that it may be derived from the drainage of the eastern slopes of our northern Rockies. It is thought that this source can alone account for the pressure. The Black Hills is named, with considerable force, as a probable source. The extensive drainage area thereof and its altitude lend character to the suggestion. Another view is that the supply is in part derived from the extensive seepage of the Upper Missouri River. The altitude of the region and the trend of the rocks and other strata give interest to this suggestion. Be these theories as they may, there is no probability, on the face of the topographic and hydrographic features, that all the wells derive their supply from any one source. The wells of North Dakota,

outside of the two at Jamestown, can not be so explained. The Devil's Lake Basin is one source, and the drainage from the Red River and of the Turtle Mountains to the north probably accounts for the artesian wells found in those sections of North Dakota.

Opinion was unanimous in the two Dakotas in support of a liberal appropriation for an irrigation survey, and the demand was made on all sides that the General Government should appropriate also a sum of money sufficient to defray the expenses of rapid geologic and hydrographic reconnoissances by which the three forms of developing a water supply already named might be fairly outlined and located in connection with the physical features of the Dakotas. It is considered especially desirable that a reasonable and speedy effort should be made to ascertain the limits and character of the several well-belts, and that some experimental wells be sunk to give knowledge to the people and courage to the settlers, present and prospective. The appeal is, in your committee's judgment, a reasonable one, especially in view of the fact that there remains at least 21,000,000 acres more of public land still open to settlement. The chief crops of Dakota are the hard wheat, for which it is famous, corn, oats, barley, potatoes, and hay. The loss by drought is put at 40 per cent. for wheat, 80 for corn, and 30 for oats.

Evidence was given showing how in a few instances the overflow of wells irrigated tracts of grain, and that such tracts furnished abundant crops while all other fields were blighted. It was stated that the rise in value of land if water security prevailed would be from \$10 to \$40 per acre. The president of the Agricultural College at Brookings estimated the immediate rise in the James River Valley alone at \$20 per acre. Ten dollars was given as the present value of farm land per acre. With summer security of water each acre would be worth \$30. That would be an increase of \$140,000,000 in one section alone. It will be unnecessary on that basis to make a calculation for the 35,000,000 acres now occupied or held by individuals, as it would be so large as to prevent belief. Yet the James River estimate given is not too high. Still the people are, as pioneers, too poor as yet to undertake the work of defining and indicating the hydrographic supplies or the most profitable manner of using and storing them. This once done by the General Government, as they claim should be the case, there would be no difficulty, it is declared, of obtaining all the capital needed for the work of development and construction. Your committee agrees with this view.

WATER STORAGE PROBLEMS IN MONTANA.

The new State of Montana, with its 93,349,200 acres of territory, is traversed from east to west by the line of the Northern Pacific road, enabling the committee to carefully examine the most important tillable valley—that of the Yellowstone—in the State; also to have the opportunity of inspecting the capacity of the famous Bitter Root Valley in the extreme northwest section, for the raising of fine fruits, and at Bozeman, in the Gallatin Valley, to see the effects of irrigation on quite an extended scale. Montana is not only one of the three largest States—the others being Texas and California—but it is without question the best watered one west of the one hundredth meridian. It is heavily timbered also; its pastoral area is great, and according to the estimate of Statistician Dodge, of the Department of Agriculture, its tillable area is not less than 32.9 per cent., or close to one-third of the total.

The river courses that drain the central basin of this land find their beginnings in the sources of the Upper Missouri, with its great tributaries of the Yellowstone, Gallatin, Jefferson, Madison, and a score

more important streams that all head in and receive their primal supply from the precipitation and drainage of the upper Rocky Mountain ranges. The valleys are usually narrow and long. The Yellowstone is an example, presenting as it does a tillable valley or bottom area of about 400 miles in length, with an average width of not to exceed 3 miles; in all about 780,000 acres. Such streams, large or small, usually present similar features of deep, narrow valleys, in which the waters appear to be slowly but steadily eroding deeper channels; then comes a precipitous rise to the mesa or bench land of from 25 to 100 or more feet in height. The mesas will widen their sections of the several hydrographic basins to from 8 to 12 miles in width. The secondary table-land or plateau is then reached by steep ascent, making them often as high as from 600 to 1,000 feet above the bottom land. These mesas and table-lands are everywhere covered with succulent grasses. They are found to be fertile in capacity, if water can be obtained. It is these facts that make Montana a typical region in which to conserve the waters by storage and subsequent distribution for purposes of irrigation.

The Yellowstone basin from a reclaimable area in the lower valley of 780,000 acres will rise rapidly under a system of scientific engineering to an agricultural capacity of from 3,000,000 to 8,000,000 acres. When storage shall be so advanced and distribution so systematized that the secondary table-lands may be reached and quickened, the largest area named will be readily compassed. Nor does this statement close the possibilities of the drainage or hydrographic basin of the Yellowstone. The tributary valleys found there, many of which are quite large, will furnish an additional 4,000,000 acres to the area of reclamation. This is illustrated in a report made by the authorities of Custer County, within which a large portion of the main Yellowstone Valley is located. That report gives the valley land area at 384,000 acres, and for fifteen other tributary valleys within the county, including the Tongue, Powder, Rosebud, and Otter, it gives their valley areas at 501,600 more acres.

The volume of water to be supplied from the Yellowstone alone is estimated by the same authority for use in the areas under consideration at 906,000 miner's inches per second, flowing under a 6-foot pressure. The testimony warrants the statement that the Yellowstone alone can furnish for irrigation purposes some 4,000,000 miner's inches. With proper storage this may be greatly increased, perhaps doubled. The wisdom of the policy which reserved as a national park the wonderland in which the Yellowstone finds its ample sources may yet be proven in ways heretofore unexpected. The storage of its quickening waters will be greatly simplified by the inability of speculative occupiers of the public lands to exploit those valuable sources. Hundreds of millions of dollars may yet be added to the nation's wealth as a consequence of the National Park reservation.

The Yellowstone is taken as an illustration of a fact impressed upon your committee by the whole of the investigation it has pursued, viz, that the earlier or primal attempts at irrigation are decidedly wasteful and often provocative of contention, disorder, and litigation. The valley or bottom lands, though the most readily reclaimable by simple local ditches, are seldom, perhaps never, the most desirable for farming purposes. It is always the warm red loams and soils of the mesa and table lands that will furnish the largest crops as a return for industry. It is on these benches, open to the sun, made up of the most fertilizing components and readily washed by water of alkali salts, that the West-

ern farmer will in the not distant future, wherever water is accessible, make from his occupation a return almost as certain and controllable as does to-day the carder of wool and the weaver of cloth. In the open laboratory of nature the earth and sun will aid, not hinder, man when regulating for himself a secure supply of water; he will from seed-time to harvest find a sufficient reward for labor, skill, and investment.

In the careful report for the State, made by the Montana Society of Civil Engineers, which will be found in the testimony taken, the following table of counties and reclaimable areas are presented as an approximate estimate:

No.	County.	Area.	Supposed under cultivation.	Supposed can be cultivated by irrigation.
		<i>Sq. miles.</i>	<i>Acres.</i>	<i>Acres.</i>
1	Beaver Head...	3,740	80,000	250,000
2	Cascade	2,570	50,000	600,000
3	Choteau	24,830	50,000	5,000,000
4	Crow Reservation	7,830	.....	1,500,000
5	Custer	22,300	30,000	2,000,000
6	Dawson	28,650	50,000	4,000,000
7	Deer Lodge	4,760	100,000	250,000
8	Fergus	7,415	100,000	1,500,000
9	Gallatin	2,800	100,000	400,000
10	Jefferson	2,080	25,000	250,000
11	Lewis and Clarke	1,789	50,000	400,000
12	Madison	4,546	100,000	400,000
13	Meagher	7,180	35,000	500,000
14	Missoula	19,580	150,000	600,000
15	Park	4,740	15,000	500,000
16	Silver Bow	760	1,000	40,000
17	Yellowstone	3,390	50,000	500,000
Total		146,000	986,000	19,790,000

Other statistics place the total area actually cultivated last year at less than 400,000 acres. The total given means all that is now occupied and used for farm purposes, grazing as well as tillage. The present year will see about 800,000 acres under cultivation by irrigation, and as much more "under ditch," that is within access to water supply thereby. No cultivation of the soil is possible in Montana without irrigation. Without ample storage of water the reclaimable area will be a limited one; with ample storage it will rise, according to different witnesses and reports, from 20,000,000 to 30,000,000 acres. The witnesses unite in declaring that with irrigation an acre of ground in Montana will exceed in productive value from 3 to 5 acres in the humid or rain-fall States. The witnesses were from Virginia to Nova Scotia, and from New York to eastern Kansas. The average production per acre is estimated as follows: Wheat, 35 bushels; oats, 50; barley, 45; corn, 28; alfalfa, from 4 to 6 tons. The percentage of productive capacity for Montana per acre may be stated as follows:

	Products.		
	Wheat.	Oats.	Corn.
Average number of bushels per acre in Montana	17.8	34.2	28.2
Average for the United States	12.8	22.3	27.0
Average per acre for whole arid region	18.9	24.9	28.9

The number of farms are 1,519, the percentage of agriculturists 20, and the average value of land is a little less than \$8 per acre. During the past ten fiscal years 6,904,461 acres of public lands have been disposed of in Montana, of which total 5,304,778 acres have been settled upon, sold, or patented during the past four fiscal years ending June 30, 1889.

The statistics presented as to irrigation ditches were very imperfect. But from such as were presented it appears that there were in 1869 of mining ditches 287½ miles, constructed at a cost of \$806,500. The present extent, including these, as many have been used for irrigation purposes also, is now estimated at 1,000 miles. There are now partially or wholly completed the following larger or district systems, constructed for rental investment by corporations:

Ditches.	Miles.	Acres to be served.	Estimated cost.
Benton Lake	35	50,000	\$175,000
Clarke Fork	38	100,000	140,000
Chestnut Valley	10	25,000	7,000
Dearborn	45	51,000	150,000
Florence	50	10,000	200,000
Gallatin	25	50,000	75,000
San River	75	300,000	500,000
Teton	40	35,000	80,000
Total	318	611,000	1,827,000

A large majority of witnesses concede that under a proper system of irrigation, storage, and distribution land now worth but little beyond the Government price of \$1.25 will rise rapidly to \$20 and \$30 per acre. The testimony was unanimous in favor of liberal appropriations for the purpose of rapidly executing a proper hydrographic survey of the arid region. It was urged by several witnesses that the General Government should go further and appropriate money for the construction of at least the main reservoir works, which the engineer's surveys may indicate as necessary. The headwaters of the interstate rivers should, it was suggested by some, be made like the Yellowstone Park, national reservations, in order to hold for the public benefit only the water sources therein. All witnesses in Montana declared in favor of considering the natural waters as public property, inalienable from the land and to be used, under public control, for beneficial purposes. It was the general opinion also that as water was an absolute quality in land values, therefore the General Government as controlling the public lands should of necessity feel obliged to point out at least the way by which the needed water could be obtained. It was asserted by all that the settlers were too poor to either do the needed work or to offer inducements sufficient to capital to enter on the construction necessary.

WHAT SETTLERS SAY OF FOREST PROTECTION.

A most interesting, though incidental, feature of Montana and other northwest testimony, brought out by the extended forest fires that were raging, was the general hostility felt towards the present system of secret land-office agents. It was asserted on all sides that the timber lands should be retained permanently as public property, that those in charge ought to be known to residents, that rules and regulations

should be adopted to effect an honest use of timber by the settlers, and it was also assumed that the resident population in and adjacent to our timber areas in the West could be relied upon, if treated with fairness, to aid the General Government in any reasonable policy adopted to prevent destruction of our timber lands by fire and depredation. These views were expressed all through the arid region wherever the question was broached. Your committee was struck with the earnest feeling manifested on this important subject and trust that legislative action may yet adequately embody this public expectation.

CONSTITUTIONAL PROVISIONS OF NEW STATES.

In the constitutions adopted for the State of North Dakota as well as Montana, the aroused and increasing public interest in irrigation is shown by the incorporation of provisions placing the natural waters under State control for their beneficial regulation and distribution. In Montana also the committee were given testimony from different sources concerning the need of changing the present systems of public land survey and distribution. Witnesses agreed on the need of reducing the homestead and in considering that with irrigation 80 or even 40 acres were sufficient. It was also suggested that, with the increase of agriculture such action would bring, the large cattle-ranches must also disappear, stock raising and breeding farms taking their place. Some of the large ranch-owners expressed themselves in support of this policy. Evidence was given showing the existence in Montana of artesian water belts. In the Yellowstone Valley there are a number of such wells, some sixty-five being found in and around Miles City. There are wells also at Helena and elsewhere. In the Lower Milk River Valley, now being opened by a new railroad, it is claimed that water in abundance is found at very moderate depths, which rises rapidly almost to the surface. The northwestern section of Montana is already famous for its early and fine fruits. Indeed, all the witnesses interested in cultivating land declared that for the growth of temperate fruits of all kinds the new State was unsurpassed. The orchard seen at Missoula gave warrant to this claim for Montana.

RECLAMATION CONDITIONS OF THE FAR NORTHWEST.

The States of Washington and Oregon present most interesting topographic and hydrographic features. In entering the first named State by the Northern Pacific Railroad, your committee had the opportunity of seeing the effect, on an area well within the arid region, of the extensive mountain lakes found in northwestern Montana and northwestern Washington, as also on a considerable section of northern Idaho. The regional aridity is subdued to a considerable degree. The extreme eastern quarter or third of Washington from north to south may properly be classified as sub-humid, while the central portion clear to the eastern foot-hills of the Cascades approaches more nearly to a general arid character. Washington, from 117° to 121° of west longitude, or four degrees, will be found a section in which the storage and distribution of water, while not at all times and places therein an absolute necessity, will always need such facilities and find them to greatly enhance its land values and industrial progress.

Entering midway of the western boundary the Northern Pacific Railroad gives the traveler occasion for seeing the character of a great area almost wholly unreclaimed, which the mesa or table-land of the

Columbia River Valley and its great tributaries presents. The Great Plains of the Columbia River to the northwest of the railroad will probably require for their arable use an extended series of hydrographic works. That they can be so reclaimed was testified to from many sources. One estimate was made of 8,000,000 acres, another of 12,000,000. According to a report of Brig.-Gen. John Gibbons, U. S. Army, commanding the Department of Columbia—

Irrigation by private parties or companies has been successfully tried in a number of valleys, viz: The Klamath River Valley, both in Oregon and northern California; the Boise River Valley, Idaho; the Snake River Valley, Washington and Idaho; the Colville River Valley, Washington; and, I understand, in the Rogue River Valley, Oregon. The rivers of this region are large and would furnish enough water to supply systems of irrigation ditches which could be supplemented by storage reservoirs if necessary, or when the demands increase.

The region around Walla Walla is rich and productive and north of this is the area called the Great Plains of the Columbia, which, although not so well known, is a promising country. Both these regions are poorly supplied with water, at least during the summer months. The topography of this section is so imperfectly known that it is impossible to determine, without surveys, the practicability of irrigating by ditches or whether it would be necessary and practicable to make use of reservoirs. The Snake River above Lewiston has falls and rapids, and thus may afford an opportunity of running irrigation ditches to the lower lands below.

All of the great bodies of water named by General Gibbons present, in the mountain sections at least, the usual characteristics of the arid region—deeply eroded channels, low, narrow valleys, abruptly rising bench-lands, opening widely one or the other side of the river, but seldom on both sides, and then again rising into grass-clad table or plateau lands. Your committee, at its North Yakima and Ellensburg sessions, had the opportunity direct of viewing the results of irrigation on an extensive scale. The Moxie ranch at the first named place illustrated in its 7,000 acres, irrigated from the Yakima River, at an average cost of \$8 per acre, what may be accomplished by private enterprise backed by capital, while at Ellensburg the Kittitas Valley offered a splendid evidence of neighborhood energy and self-dependence. The Yakima Valley offers 200,000 acres of bottom lands for reclamation and at least a million more in available bench-lands. The rain fall of the region is also sufficient to secure a large area of "subirrigated" land. That is to say, where the soil retains below the surface much of the precipitation and drainage that percolates into it.

Evidence taken at North Yakima and elsewhere in eastern Washington gives the production per acre of wheat at from 35 to 50 bushels; of oats at 60; of barley from 50 to 80; alfalfa yields from 6 to 10 tons per year, while potatoes will return more than 500 bushels to the acre. One half of eastern Washington needs storage and full facilities of irrigation. The cost will range from \$3 to \$5 per acre, and there may probably be found an abundance of water for storage. The cost of water in irrigation is about \$1.50 per acre. Says one of the witnesses:

The Kittitas Valley without water is but a sage-brush desert; but upon being irrigated it becomes a garden spot and produces bountifully of cereals, fruits, and vegetables. About 22,000 acres of land are under cultivation in the valley. All small fruits, as well as apples, plums, pears, etc., grow to perfection; peaches do not do so well, except in localities bordering on the Columbia and Wenatchee Rivers. Vegetables of all kinds and of the finest quality are grown upon every farm. It is nothing uncommon for cabbage to weigh 50 pounds and upward; onions, 5 pounds, etc. Every farm in the valley is an example of individual effort in reclaiming the desert with muscle and water.

A former Federal judge, J. R. Lewis, of North Yakima, stated that—

In these valleys of the Yakima, including the Nachez Valley and the Yakima Valley proper, and the valleys tributary to the Yakima, the irrigating season commences in—

the months of May and June principally. Very little land west of the Columbia River, in what is known as the Columbia River basin, is susceptible of cultivation without irrigation except, perhaps, for hay. Many people produce hay along the river by sub-irrigation. The finest store-house we have is our snow-clad mountains. Fort Adams is an everlasting store-house. The waters of the Yakima and the Tietan flow in there in ordinary seasons, and without any storage whatever those would irrigate an extremely large area of country.

Experience and observation show me that for a wheat crop of 45 to 50 bushels is a fair average on the base of the Blue Mountains. You can get 60 bushels of oats here on well-irrigated land, and from 60 to 75 bushels of barley on well-irrigated land, but there is very little ground in this vicinity that is properly irrigated. The Kittitas Valley is well irrigated, and you will find men talk of 75, 80, and 100 bushels of barley, and truthfully so, because they have the system established. On the Indian Reservation, just below us here, which must shortly be opened, there are 300,000 acres of land that can be irrigated.

In the extreme southeastern section, around Pasco, Walla Walla, and east to Lewiston, in Idaho, there is a region already famous for its fine fruits and vegetables, in which the use of irrigation adds enormously to the value of the land. It is a region also of accessible and not very deep artesian water, and it illustrates, too, the rapid increase of precipitation at rising altitudes. The average annual rain-fall at Walla Walla is given for five years past at 18 inches; at Dayton, 30 miles distant, it reaches 27 inches. That is a rise of less than 700 feet. To be accurate, the height above sea-level at Walla Walla is stated at 1,000 feet; at Dayton, at 1,675 feet. The difference of 10 inches, then, is at the rate of one third of an inch per mile, or of $1\frac{1}{3}$ in every hundred feet. The advantages offered by this region are testified to by some State census figures, which show that the proportion of settlement in Washington during two years past has been in favor of the section east of the Cascade range. In 1887 there were in Washington 144,000 persons; in 1889 the estimate made from county returns showed 240,000. In the western counties the total population was 142,132; in the eastern counties it was 97,868, an excess for the west of 44,264. The total increase for two years is given as 95,991. Of this, the region between 117 degrees and 121 degrees, or East Washington, got 41,298, while that west of the Cascades got 35,693. This illustrates the tendency of population towards the areas where agricultural security may yet be maintained by the will of man.

Oregon is estimated to have received 100,000 new settlers during the same two years or less, of whom 60,000 at least have remained east of the one hundred and twenty-first degree of west longitude. During the past twelve fiscal years ending June 30, 1889, these two States show a public land settlement as follows: Washington, 13,335,937.03, and Oregon, 6,149,540.05 acres, or a total of 19,485,477.08 acres. The amount paid into the land offices during the fiscal year of 1888-'89 was, for Oregon, \$35,332; and for Washington, \$39,538, or \$74,870; or a total of one-eighth of the receipts for the whole arid region. Washington has made natural waters public property by constitutional provision.

The arid and subarid sections of Oregon are somewhat more extensive than the similar ones in Washington. Their great feature is the drainage basin of the Columbia River, in the north, with its extensive tributaries—the Deschutes, John Day, White and Powder Rivers—and on the east the lower valley of the Snake River, which forms the western boundary line of Idaho for two-thirds of its length. Below that is the Oregon portion of the Owyhee River and its branches. In the southwest, the Klamath River and lakes form an extended drainage basin in which large irrigation operations have already commenced. Evidence taken at the Dalles, Baker City, and Caldwell confirmed the extent of reclaimable land, of needed water storage, and of the need of

capital as well as of an extended system of surveys, in order to bring out the facts which are desirable in order to prevent disastrous failures and a great waste of energy and industry. As far as can be estimated from the scattered facts presented, eastern Washington now has about 50,000 acres under irrigation, while the corresponding area of Oregon has about 100,000 acres. In the latter State there are about 50,000 acres under ditch, but not yet cultivated.

IDAHO AND IRRIGATION PROGRESS.

The condition of Idaho, as to the hydrographic facts, the available area for reclamation, the facilities for artificial storage, and the awakened interest of the people, was found to be among the most satisfactory of the communities visited by your committee. A considerable area to the north and to the west of the Sawtooth and Bitter Root ranges is considered in the Territory as outside of the arid range. This area embraces the counties of Idaho, Latah, Nez Perces, Kootenai, and Shoshone. A portion of Lemhi is also included. Unquestionably, however, this section will also be benefited and farming pursuits rendered more secure by water storage and distribution. The remainder of the Territory embraces 32,183,040 acres, of which about 7,000,000 acres are estimated to be irrigable and arable, fertile in soil, and having accessible storage capacity and an available water supply.

The testimony taken in Idaho covers carefully every section. From the statements so presented the committee offer the following tabulation as illustrating the main results and facts of irrigation enterprise:

Idaho ditches for irrigation, areas under water, etc.

Counties in which irrigation now exists.	No. of completed ditches.	Ditches.	Irrigated in 1889.	Estimated No. of acres irrigable.
		Miles.	Acres.	
Ada	*62	*448	60,000	900,000
Alturas	10	18	14,500	118,000
Bear Lake	69	206	21,500	39,000
Bingham, North	†16	253	245,000	2,238,000
Bingham, South	70	264	39,250	267,500
Boise	‡20	60	83,500	.....
Cassia	298	299	82,000	656,400
Elmore	‡50	‡25	10,000	230,000
Logan	‡65	‡125	50,000	1,250,000
Lemhi	250	‡300	9,715	500,000
Oneida	‡65	‡100	38,760	196,000
Owyhee	66	‡53	21,275	248,500
Washington	‡270	{ 84 } { 133 }	40,000	500,000
Total	1,311	2,418	715,500	7,141,400

* This includes three ditch systems, embracing 207 miles, incomplected when the visit of committee was made.

† The sixteen ditches given do not include the laterals. At an average estimate of 400 acres per ditch, the mileage would be over 600.

‡ Estimated on the basis of 2 miles per ditch serving 400 acres. This is near enough for an approximate; below rather than above the facts.

§ The 84 miles are the definite lengths given of new ditch systems; the balance is an estimate.

The foregoing table shows some notable facts. The counties wherein are found the largest irrigated areas, as well as the great number of ditches with the smallest service to each, are those in which so large a number of Mormon citizens have settled. In Idaho, as also in Arizona, where there is likewise a considerable body of this peculiar people, they reproduce, as they have done in Utah, some of the physical and mate-

rial facts of the Orient, from which they have also derived their peculiar religious-social faith and practices. The smallness of the ditches constructed indicate the limited area cultivated by each individual or family. It is, however, always sufficient to support them in that primitive plenty which constitutes their standard of life. The location as well as the length of the irrigation ditches seems also to instinctively follow the customs and habits of the Orient. The petty works, the careful observance of water rights, the economy of water observed, and the co-operative instinct, rather than plans, which mark their dealings with reclamation from aridity are all traits that may be found as characteristics of Mohammedan or other Eastern countries, where a strong sacerdotal régime has not only dominated the character but directed the daily pursuits of the people under it. The primary nature of this work can be seen when an estimate is made of the cost per acre.

In Bear Lake County the total cost for the 21,500 acres irrigated is given at \$73,500, or a fraction over \$3.60 per acre. The ditches of the northern portion of Bingham County cost \$435,000, or a cost per acre of \$1.775. Small as this price appears to be, it is necessarily costly, because wasteful. As the water in sight is absorbed, storage becomes a necessity, and the result is the abandonment finally of the small ditches, and the reconstruction of service works on a larger and, of necessity, costlier (at the outset) scale. Taking the medium between the two rates given, and the cost per acre of irrigation in Idaho may be set at \$2.66 per acre, or a total for 715,500 acres of \$1,187,000.

The extensive river system of Idaho renders the reclamation of its arid lands a very interesting problem. The need of storage was insisted upon by all witnesses and in all the reports offered. A majority appeal to the General Government for aid, and all are urgent for a complete hydrographic survey directed mainly to utilitarian results. The importance of the river system of Idaho can hardly be exaggerated from the stand-point of reclamation; the number and volume of minor mountain streams must also be considered. Some slight idea of the water supply may be obtained by the presentation of a few of the estimates made in the testimony:

	Cubic feet per second.
Flow of Snake River (at Eagle Rock).....	5,000
Flow of Salmon River (in Cassia County).....	1,820
Flow of Boise River.....	6,000
Flow of Payette River.....	1,000
Flow of Weiser River.....	180
Flow of Big Wood River.....	154
Flow of Raft River.....	745

These estimates are necessarily partial. They embrace with tolerable accuracy the surface drainage flow above the point of measurement, but they take no account, of course, of the addition to the river volume accruing from the remainder of its other local areas of precipitation and drainage.

According to the testimony given the average annual rain-fall is about 13 inches. The snow-fall is given at an average of 6 cubic feet of packed snow on the ranges. This will give at least, in melting, about 2 cubic feet of water. The capacity, then, of Idaho for storage by main reservoirs at high altitude and at or near the sources of its great streams becomes one of the problems that may be approximately measured and calculated upon.

The testimony taken in Idaho will all bear careful examination. The Territory will take a leading place on irrigation questions.

THE COMPARATIVE GROWTH OF GRAIN.

Its other material conditions are also strengthened by the fertility of the soil, for, in addition to the grains, grasses, and roots of the Northwest, Idaho produces in remarkable profusion all the fruits of the temperate zone. The exhibition of such fruits, as well as of vegetables, made before the committee at Boise City, was certainly one of the most remarkable in quality, quantity, variety, and size of the whole trip. The average for the whole arid region is less than 3 per cent. The percentage of tillable land in the Territory is given by Statistician Dodge at 37 per cent., being, with the exception of Utah, the highest in the arid region. Grass land is given by the same authority at 23.2; wood land, 3.6, and unproductive as high as 36 per cent. The average yield of wheat is 23.2 bushels per acre; of oats, 39, and of corn, 33.1. Montana is the only arid State surpassing Idaho as to the latter grain. The difference between Idaho and the balance of the country is, as to wheat, 1.7 bushels less; as to oats, 21.9 bushels more, and of corn, 4.8 bushels more. The average yield of oats is higher in Montana than elsewhere in the arid region. The farming population is but 25 per cent.; the number of farms is 1,885, and the average value per acre is set down at \$8.64, being sixth in ratio to other arid divisions.

The total amount of public land taken up, sold, and patented in Idaho outside of mineral land, during the twelve fiscal years ending June 30, 1889, is given at 2,597,739.39 acres, of which total over 1,700,000 acres have been disposed of in the last half of the period. These figures are of value as showing the growing westward tendency of settlement. We may individually regard such present occupation of arid lands as unwise; but as legislators charged with the duty of observing the facts and reporting thereon as a basis for immediate or future action, it is not possible to avoid the conviction that such settlement will proceed, whatever may be said to discourage it.

UTAH—ITS SMALL FARMS AND WATER USAGES.

The conditions surrounding irrigation in Utah deserve the most careful review. They differ in many respects from other sections of the arid region. This difference begins with the physical features, and runs into all the social economic aspects also. The configuration of the Territory renders it for reclaimable purposes one of the most difficult in the arid region. Its only great river system, that of the Green and Colorado, is in its physical features of little service for reclamation purposes, for their courses are mainly marked by the existence of the precipitous cañon region. Outside, then, of the reclaimable portions of the basins of Salt and Utah Lakes, and of the Bear River plain to the north, with the small valley areas that belong to these portions, the cultivated sections of Utah are widely scattered.

The industrious people who have held this Territory since early in the "fifties" have made available in detached portions of Utah a considerable area of arable land by the careful use of every spring, pool, creek, or mountain stream that can by simple means be coaxed down to valleys or plains below. As will be seen by the table inserted hereafter, the total area reported as irrigated and producing crops in 1889 was only 412,269 acres. Allowing for omissions and making the total 450,000 acres, the figures show a loss by the drought of fully 200,000 acres. There are about 800,000 acres under cultivation in Utah, a considerable area being benefited by natural subirrigation. An estimate

of 200,000 acres more will cover all that could be cultivated by the present ditches, and 3,500,000 acres is the outside estimate given in the evidence of the amount reclaimable under the reservoirs proposed by witnesses and in county reports.

Irrigation has prevailed in Utah for nearly forty years. Not one-fifth of the present population could be sustained without it upon the soil of the Territory. As it is, Utah feeds not only its own population of at least 175,000 persons, but has a considerable surplus for sale to others. The settlements of Utah are mainly located along the center of the Territory, from its northeast to its southwest corners. Beginning with Rich and Cache Counties, a strip of about one of the smaller counties wide proceeding southward is occupied by the Mormon farmers. In this area will be found Salt, Utah, and Sevier Lakes. It will have the valley of the Bear River to the north and of the Virgin to the south. The area thus occupied will average about one degree, or 60 miles, in width. The wisdom of the selection is easily seen when the hydrographic features therein are considered. Elsewhere there are smaller communities, but at least 125,000 are located within the east and west portions of the dozen counties into which this central belt of Utah is subdivided.

These communities are favorably located to command all local trade and communication, as well as the several sources of water; but the main concentration referred to is a striking characteristic of the sagacious economic manipulations which mark the settlement and development of the major portion of Utah—of all of it in fact outside the chief railroad towns and a few mining districts. It is these things which have given, as one of their special features, such an interesting development to irrigation under them. When the geographical significance of this line of settlement is taken in connection with the larger configuration of our mountain areas outside of Utah, it is difficult to escape the conclusion that it has been selected and directed by ulterior desires for controlling the development north and south of the whole region.

THE SMALL FARMS OF UTAH.

Be that as it may, it will be seen that Utah supports a considerable farming population—more, perhaps, per acre than elsewhere in the United States, unless a few of the California fruit colonies are accounted for. The farmers of Utah have large families as a rule; ten acres support a majority of them. The largest farm reported to the committee had but 200 acres in it. The average Utah farm is about 25 acres. There are a few ranches on which alfalfa and other fodder plants are raised on a large scale. Very few Utah farms are under mortgage. The average length of the ditches does not exceed 3 miles. Their average service may be estimated at 300 acres each. One cubic foot of water has supplied during the past year about 75 acres of land. The cost of water is less per acre to the Utah farmer than elsewhere within the arid region, ranging, as it does, from 25 to 60 cents per acre. In a few instances only it will cost \$3 per acre, but it seldom reaches even \$1.

There was not a single corporation in Utah at the time of your committee's investigation charging royalty and annual rental for water. There has been but one incorporated with that object in view. Nearly every mile of canal or ditch in the Territory has been constructed by combined and neighborhood effort. In actual cash these ditches have cost not to exceed \$2.50 per acre; counted as paid in labor, however, and the cost has been about \$1 per acre. That will make the nominal

cost for 650,000 acres \$2,600,000; the actual or cash cost may be put down at \$1,625,000. There has never been a lawsuit over water rights; this at least was the general testimony of the witnesses.

The area irrigated last year is given in the table that follows:

Counties reported.	Irrigated areas in acres, 1899.	No. of canals.	Miles of canals.
Beaver	9,500	*32	*96
Bor Elder	17,500	12	76
Cache	41,444	40	110
Emery	14,825	*34	*102
Garfield	5,000	*17	*51
Iron	6,997	*23	*69
Juab	4,000	*13	*39
Kane	1,825	9	*18
Millard	13,500	42	*120
Morgan	8,648	*29	*87
Pi Ute	12,135	31	*98
Rich	42,811	*143	*429
Salt Lake	38,587	37	213
San Juan	1,025	*4	*12
San Pete	3,500	*12	*36
Serier	17,619	*60	*180
Summit	8,500	*28	*84
Tooele	6,250	*21	*63
Uintah	8,983	*30	*90
Utah	69,126	346	*1,488
Wasatch	18,000	*60	*180
Washington	18,892	31	186
Weber	44,052	25	75
Total	412,669	1,079	3,903

* These are estimates made on a uniform basis of 300 acres to each ditch and of laterals of 3 miles in length.

These results have been attained by neighborhood combinations, directed from first to last by a managing force which has stood to the farmers of that Territory in place of capital and corporate direction. It can not be denied that the result is unique, and the average independence and comfort obtained is as remarkable. The facts brought out in the Utah evidence offer examples worth considering and following as to the capacity of an industrious, energetic, though poor and struggling, community, to obtain even from aridity and desert a sufficiency of support, amounting indeed to substantial comfort. That has been done, too, without large compensation for capital. It is not explained upon the title system in vogue in Utah, for very little has actually passed in the construction of any portion of the Utah irrigation ditches. Its success belongs far more to the spirit which organizes neighborhood effort and seeks in co-operation to achieve self-help.

THE WATER LAWS AND THEIR CHARACTER.

The legal aspects of Utah irrigation are as remarkable as the economic ones. Indeed they are related to each other, and the laws could hardly have been framed by any other community. But their value extends beyond the locality for which they were framed. Prior appropriation is the foundation, but so modified by the uses of water in the interests of the community as to make of that principle something quite broader and more equitable than has elsewhere been the case. In other words, priority has not been abused in Utah. It is not regarded as giving the right to a monopoly. Accrued water rights then are protected by the Territorial laws, as is the case throughout the arid region. The county selectmen are *ex officio* water commissioners, with the

power to record all appropriation and regulate the distribution of natural water. Appropriators can be persons or corporations. Rights are divided into primary and secondary, the latter being a feature of water legislation peculiar to Utah. A primary right vests under the following circumstances:

(1) Whenever any person or persons shall have taken, diverted, and used any of the unappropriated water of any natural stream, water-course, lake, or spring, or other natural source of supply.

(2) Whenever any person or persons shall have had the open, peaceable, uninterrupted, and continuous use of water for a period of seven years.

A secondary right to the use of water for any of said purposes is hereby recognized and acknowledged to have vested and accrued (subject to the perfect and complete use of all preliminary rights) to the extent of and reasonable necessity for such use thereof, under any of the following circumstances:

(1) Whenever the whole of the waters of any natural stream, water course, lake, spring, or other natural source of supply has been taken, diverted, and used by prior appropriators for a part, or parts, of each year only; and other persons have subsequently appropriated any part, or the whole, of such water during any other part of such year, such person shall be deemed to have acquired a secondary right.

(2) Whenever, at the time of an unusual increase of water exceeding seven years average flow of such water, at the same season of each year, all the water of such average flow then being used by prior appropriators, and other persons appropriate and use such increase of water, such persons shall be deemed to have acquired a secondary right.*

The measurement of water is definitely provided for by "fractional parts of the whole source of supply" or time limit, or by a specific ratio of measurement, or this combined with time limit. Provisions are made for repairs, damages, continuous use and service, against waste, and for the return of unused water to its proper channel; also for pro rata distribution when supply fails in volume, as to equal right of way, and for the organization of local copartnerships or corporate direction. Another act provides for irrigation districts and their lawful control, with trustees, and the powers as to water and its control and use, of any sub-civic or county body. The probate judge of Salt Lake County described the manner in which land and water are allied and controlled. As to the distribution he said:

There are two or three systems. We have, first, the incorporators on the streams, controlling it themselves—they agree how it shall be manipulated; second, the county courts that matured and organized irrigating companies; and, third, private corporations, taking out charters the same as any other corporation would, as, for instance, a person or a company of men settle upon a stream and appropriate the water in it. In early times they had sufficient to irrigate what land they would break up. Those we will term the primary owners of the water. Afterward others would come who, finding a surplus of water in the stream, would appropriate still further water, and so on until all the water of that stream would be taken out. They dug their ditch, gave it some name, and took what water they could through their land. In establishing some streams there would be what is known as the first, second, and third right. The third right, when there is a scarcity of water, shuts off the entire stream, and the second and first rights take the entire stream. The owners of each of those ditches meet and appoint what is called a "water-divider" or "water-master," who has control of the ditch for that year, and whose duty it is to divide the water of the streams into ditches, as, for instance, if there were four streams drawing water, they would appoint a divider to turn the water of those streams into the ditches, and the water-master would take the water as it would get into the ditch and give it to the owners as their rights might appear. I do not think there is an irrigating ditch in the Territory under the irrigation law; they have all taken out private charters.

The witness said that is an incorporation where certificates of stock are issued under the general laws of the Territory. They elect their board of trustees and manage the affairs of the company. Those trustees appoint a water-master, who takes the number of shares each owner of it has and divides to each his proportion of the water that

* From Compiled Laws of Utah, sec. 2781.

comes through a certain ditch from the stream. Those streams are mostly artificial streams, having been taken out from some large body of water. That system prevails more on the west side than on the east side, though there are some on the east. The stockholders have the land, but the water right can be transferred without transferring the land. It is a water right independently of the land.

Yet the water must be "in place," and in order to use it, the land served by that way must be obtained. As a practical fact a water right, that is, one share in a corporation, represents only the service of water for 1 acre of land. And it is a particular acre in a special place. Therefore the one share of water can only serve that 1 acre of land or rather any 1 acre within the area to be irrigated by that particular body of water in the service or duty of which one share has been obtained. In proof may be quoted the following:

I do not think there is a corporation in Utah Territory that rents water exclusively.

The CHAIRMAN. Then the only renters of water are the stockholders in these corporations who have a surplus, who have more stock than land, and they sell their surplus water to their neighbors?

Mr. SMITH. Yes; that is the only system in vogue in this Territory to-day.

HOW WATER IS DISTRIBUTED.

In the distribution of water the horary or time system has been adopted. The irrigation survey engineer states that the following forms indicate the method of distribution by "the hour," as is the case in Spain:

No. —

TIMPANOGOS IRRIGATION TIME TICKET.

Mr. ———. On ———
every alternate week, from
— o'clock — m., and until
— o'clock — m., ———
amount of stream, all of the
water in said ditch.

Water-master.

No. —

TIMPANOGOS IRRIGATION TIME TICKET.

Mr. ———: You are entitled to the use of water
from the Timpanogos Ditch on ——— every alternate
week, from — o'clock — m., and until —
o'clock — m., ———; amount of stream, all of the
water in said ditch; when you are required to discon-
tinue to use and turn it off.

Per ———, Water-master.
Deputy.

PROVO CITY, UTAH, ———, 18—.

The annexed blank receipt shows the manner of meeting the water-tax levy on proof of labor performed:

No. —
Am't of labor, ———
Am't of cash, \$ ———
Total, \$ ———
Issued to and received by
Date, ———, 18—

No. —
Received of ——— days' labor, \$ ———
Cash ———
Total ———
In full for his water-tax, for the year ending March
1, 18—.
Water-master.
PROVO CITY, UTAH, ———, 18—.

Within the Territory of Utah will be found several varieties of climate, ranging almost from semi-temperate in the north to semi-tropical in the south. The production of corn is limited; that of wheat and oats is large. Wheat brings 80 cents a bushel and runs from 25 to 30 bushels per acre. Oats bring from \$1.16 to \$1.60 per hundred pounds. Potatoes will give 300 bushels to the acre. One witness put the probable increase of cultivation by artificial storage at 200 per cent.; that is, from 650,000 to about 2,000,000 acres. The agreement was general that a

farm of 40 acres was quite sufficient for profitable cultivation. In the southern portion of the Territory the raising of fruit is claimed to be a success. Artesian water is found in several counties and over large areas.

The disposition of the public land domain in Utah for the past twelve fiscal years outside of mineral lands has been 2,681,605.96 acres. The percentage of Utah in farms is 1.92 of the whole. The entire arid region has but 2.85 per cent. Of tillable land Utah has (whether or not there be water for the same) 45.5 per cent. of its whole area. Of grass it has 18 per cent; of wood-land but 3 per cent. The unproductive area is set down at 11.4 per cent. of the whole. The question of reclamation in Utah then is, as elsewhere, one of mountain precipitation, of subterranean supply, and of artificial water storage and subsequent distribution. The rain-fall ranges from 7 to 17 inches per annum. The snow-fall is from 5 to 25 feet. In the mountains the precipitation is as 3 to 1 in quantity over the lower lands. The average yield of corn per acre is given at 22.5, of wheat, at 17.8, and of oats at 26.3 bushels—an average which is close to the normal mean for the whole country. With these figures, it is evident that Utah holds larger promises than its past has achieved.

NEVADA AND ITS RECLAMATION PROBLEMS.

The hydrography of Nevada certainly presents most remarkable features. Difficult as they are, examination offers a great deal for the encouragement of comprehensive plans of reclamation. The prevailing ideas of an almost impossible aridity will be seen to be much exaggerated and mistaken. The committee ask a careful study of the evidence and reports taken in connection with this State. Indeed, it may be said that the whole question of arid reclamation by the storage and distribution of water on a large scale, in the interior portions at least of our mountain territory between 104 and 121 degrees of west longitude, will depend in a great degree upon its feasibility within the vast drainage bowl in which the State of Nevada, politically speaking, is embraced. That State especially emphasizes the physical and legislative problems also, which would seem at times in considering the possibility of conquering aridity by reclamation through water storage and conservation, with subsequent distribution by irrigation, to be almost in conflict with the boundaries of States and the self-government thereof. The water for storage in Nevada must be drawn largely from drainage areas outside of the State boundaries. Yet these are strictly so within the drainage basins that belong to Nevada—speaking in a physical sense.

The water area of Nevada proper is estimated at but 1,081,600 acres, while the land area is not less than 70,656,000 acres. The ratio is therefore less than one acre in seventy, the smallest water area of any subdivision of the Union. The arable land is set down in the report of the State reclamation commission at 20,000,000; the grazing at 30,000,000; mineral at 15,000,000, and forestry at 2,000,000 acres. The balance is desert, alkali, flats, sulphur, borax, and saline deposits. There are but thirty-five rivers and streams in the State, while of lakes and ponds there are nine hundred and twenty-five reported. All the streams of any large value, except one, have their rise outside of the State. The Colorado has its sources in those of the Wind and Green Rivers. Carson, Walker, and Truckee, all of importance for irrigation purposes, have their sources within the lines of California, but well within the tributary drainage region to the west. The Quinn, Bruneau,

Owyhee, and Salmon are also parts of the waters of Idaho and flow into the Pacific, while the Virgin flows through both Utah and Arizona and finally into the Gulf of California. Of the 1,761 miles of flowing streams within Nevada, at least 850 are portions of streams rising and flowing from and into other States.

The Humboldt is in fact the one stream of importance, rising and sinking within the area of the State itself. The lakes, situated mainly in the western part of Nevada and on the eastern slopes of the Sierra Nevada, are, however, the most important features in the reclamation problem. The seventeen important bodies of such water cover an area in Nevada of 1,914½ square miles. This will be nearly doubled if all the mountain lakes which physical geography plainly shows are within the proper drainage areas of Nevada, are to be considered.

Reclamation from aridity then must be achieved in Nevada by means of the storage of water at high altitudes and on a large scale. This does not, however, exclude some moderate areas to be reached and reclaimed by local storage and distribution, or even as to a considerable number of acres by the systematic exploitation and restoration to the surface of under-ground waters by means of artesian wells and the use of natural springs. It is claimed by one authority that there is water obtainable by storage to reclaim 12,000,000 acres. The United States Surveyor-General and others make a high estimate, and give the possible total at from 16,000,000 to 17,000,000 acres. There is estimated as in sight water sufficient, with proper engineering, to reclaim 3,000,000 acres. Such reclamation now calls for a large duty of water. It is estimated at not less than one miner's inch per second for each acre.

The area of land, irrigated and cultivated, other than as meadows or for hay, is about 70,000 acres. There are 646,343 acres inclosed, and of these the cultivated area is but 141,496 acres. About 14,000 acres are in small grains and potatoes, yielding of wheat nearly 24, of oats about 29½, of barley nearly 30, and of potatoes 140 bushels to the acre. The average yield of hay, principally timothy and alfalfa, is over 3½ tons per acre. The smaller vegetables occupied in 1888 about 1,350 acres and made large returns. Fruit trees, temperate and semi-tropical in character, grow well, and in the valley of the Virgin, etc., in Lincoln County, southern Nevada, cotton and other semi-tropical products have been grown readily and yield largely. It can not well be said that Nevada lacks in fertility or climatic suitability. On the contrary, it was declared to your committee that—

No more delightful place to live can be found upon the continent; no part of America has so many days of sunshine with delicious evenings and nights of comfort; no corner of the Union has the freedom from malaria, consumption, and kindred diseases, and in no State is agriculture pursued with greater ease or larger profit. The farmer is certain of his crop as well as of his market. Ready sale can be had for all that can be raised. Whatever grows here grows to the limit of quality. The wheat, in grain and straw, is as clean as the gold from the mine. The potato is a sealed package of white meal; the apple is the best of its species. In addition to all kinds of grain and grasses Nevada is particularly well adapted to the apple, the potato, the plum, and the pear, besides all small fruits and berries, while certain kinds of grapes grow to perfection.

Some idea of the capacity of the State can be gained from studying the county of Washoe, which raises yearly 60,000 tons of the best kind of hay, besides wheat and other grains. It seems especially well adapted to alfalfa or lucern.

The reclamation of large areas of Nevada resolves itself, then, into two questions: They are, from whence can sufficient water be obtained, and where can it be stored. The matter of distributing when stored is one to be readily solved by good engineering. As to obtaining the water for storage in a region where the water area in sight is less than as one

to 70 acres, and over the lower bench-lands and valley sections of which the average annual rainfall for the State is not over 6 inches, the questions involved are to be met only by consideration of the massive and controlling topographic and hydrographic features that dominate the whole region.

NEVADA'S NATURAL STORE-HOUSE FOR WATER.

Nevada's mountain ranges are the great snow-catchers. They form, therefore, its store-houses of water. One inch of water to eleven inches of fresh snow is a moderate estimate. On the basin and valley lands only a few inches of snow falls during the winter. Rarely, according to the surveyor-general and others, does it reach 25 inches. At and above 6,000 feet there is an average fall annually of 18 feet of snow, giving at least 19 cubic inches of water. Sometimes it will be three times as much, as has been the case during the past winter. The ranges within the State run parallel with the Sierra, and their area is not less than 52,000 square miles. Of this, at least 18,000 square miles have snow upon them all the year round, at a depth of from 4 to 26 feet. The ranges will give at least 16 cubic inches of water for the whole State. And this does not include the eastern slopes of the Sierra Nevada, which are much greater. The United States surveyor-general says of this precipitation, that—

The snow caught by Nevada's mountains does not stay all the year upon their tops and sides, for the warm winds, by their natural direction in proceeding from the equatorial regions toward the great easterly circulating belt along the forty-second parallel of latitude, fall into the valleys of Nevada and follow them throughout the extent of the State in a south to north direction and eat away the snow from all the subsidiary ranges, thus causing streams of water to run down the cañons from early spring until about the end of July, by which time nearly all of the snow which lodged below 6,000 feet altitude is melted away and the water from it has run down to the plains below and has been absorbed by the soil or can be seen collected in a thousand shallow lakes of greater or less extent—natural reservoirs. With proper engineering, I believe that 90 per cent. of this, the first fruits of the winter storms, can be saved for the production of what are called here second crops, which in most cases will be limited to the foot-hills along the bases of the mountains, and matured in the months of September and October, by which time the greater part of this store of water will become exhausted, to be again replenished the succeeding spring. The remainder of the snow, which from its altitude is above the reach of the warm air currents spoken of, melts very slowly and much of it remains from year to year.

To the 16 inches storage to be gained from snow at the 6,000 feet must be added what falls below that altitude. It is estimated at 5½ feet of fresh snow, yielding at least 6 inches of water. This gives from snow alone a possible precipitation in water of 22 inches. The drainage shed of the eastern slopes of the Sierra Nevada is 4,800 square miles. This area is all tributary to Nevada; that is, it is part of the State's water-shed. According to the surveyor-general, this section stores the water as follows:

	Snow-fall.	Water.
	Feet.	Inches.
250 square miles	14½	14
1,560 square miles	17½	19
1,830 square miles	33	36

The remainder of the snow supply forms seasonal streams only. Over 90 per cent. of a possible 42 inches is now lost by evaporation and seep-

age. The latter fact produces the under-ground water supply known to exist in southern Nevada, in both Nye and Lincoln Counties, where it is claimed that, by reason of the large fall of $7\frac{1}{2}$ feet per mile, a considerable deposit of artesian water has been found.

As to the conservation of water by storage, a statement made by the Washoe County commissioners illustrates its possibilities. It is reported that not over 3 per cent. of the "water in sight" is now used in that county, but that with storage 35 per cent. of it could be utilized.

THE LAKES OF THE SIERRAS.

The lakes of the Sierras afford the most interesting series of facts. One-third of Tahoe, the largest of the score or more valuable natural reservoirs, lying along the western boundary line, is within the State of Nevada. Donner Lake, which is one of the chief reservoirs of the Truckee region, is just within the boundary of California. To the north of Reno, lying along the eastern slope of the Sierra Nevada, may be found the upper, middle, and lower lakes of Modoc County, Horse, Eagle, and Honey Lakes in Lassen County, with Donner in Sierra County, all in the State of California, but as part of a great drainage basin, naturally affiliated with the area of which Nevada forms the largest portion. Lake Tahoe, at an altitude of about 6,000 feet, with a drainage area of 1,200 square miles, a surface one of 111,360 acres, a depth of many hundreds of feet, is the crown of the system, both in its wild mountain beauty and its wonderful adaptability to the needs of man in this matter of reclamation. Below Tahoe and within Nevada are the Walker and Carson Lakes, the Carson and Humboldt sinks, and still further south, Mono Lake in California.

The central river systems on the Nevada side of the Sierras may well be compared with that of the San Joaquin Valley on the west side of the great range. The examination of a good map will illustrate this. Inside Nevada, and close to its western border, may be found the Winnemucca and Pyramid Lakes. They lie north of the Central Pacific Railroad and are the "sinks" of the Truckee River. These basins or bowls illustrate what may be done in the way of storage, as the Winnemucca or Mud Lake is an example of a reservoir formed naturally. Fifty years since it was in general a mud bed. The Indians and others drove across it, making a well-defined road at points where the water is now 60 feet deep. One of the outlets was choked by a land slide and filled with trees and earth, making a compact dam, growing stronger every year by the impact of the waters. Surveyor-General Irish says:

In 1844, at the time of General Fremont's first trip through this region, it was slowly filling, by reason of a great dam of brush and cotton-wood timber, which was pushed into the Pyramid Lake channel by a great freshet in the river some time before that date. The filling has continued to the present time; so that now, as before stated, the lake is about 70 feet deep, and completely covers all its bed. The length of this lake is 28 miles, and its average width $6\frac{1}{2}$ miles. Thus it is seen that in fifty years' time the Truckee River drainage has stored in Mud Lake 2.4 cubic miles of water. But this is not all of its storage capacity, for within the fifty years spoken of it has again and again filled up Pyramid Lake, a much larger body of water, through a rise and fall of at least 25 feet; so that I am disposed to place the storage by the Truckee River for a period of fifty years in these two lakes at not less than 5 cubic miles of water, over and above all the losses by evaporation and percolation. This would be at the rate of 14,719,795,200 cubic feet per annum, which sum is the result over and above all losses by evaporation, percolation, and used by irrigation for the past twenty to fifty years. This amount of water would cover a square mile 7,795 feet deep each year if diverted from the lakes and so used.

Such facts as these point with unerring certainty to the possibility of storage on a very extended scale. The State authorities are not un-

mindful of these facts. A board of reclamation has been appointed and an appropriation of \$100,000 made for the commencement of a storage system. There is a very good State weather service. The water legislation recognizes the principles of public property and prior appropriation as qualified by beneficial use, when supervised by district and State authority. One of the civil engineers engaged on the irrigation survey last year made an examination of the Sierra Lakes and other storage possibilities for both the General and State Governments. Some of his estimates may be esteemed as oversanguine, but making all due allowances, the calculations are remarkable enough to be quoted.

	Surface.	To be raised.	Water capacity.
	<i>Sq. miles.</i>	<i>Feet.</i>	<i>Cubic feet.</i>
Donner Lake.....	55	40	5, 575, 680, 000
Tahoe Lake.....	174	80	111, 513, 000, 000

At to the river valley sites, selected for storage, the following will do as examples:

Valley.	Length.	Altitude above sea-level.	Water capacity.
	<i>Miles.</i>	<i>Feet.</i>	<i>Cubic feet.</i>
Hope.....	5	7, 658	6, 969, 600, 000
Long.....	20	5, 078	} 5, 635, 680, 000
Diamond.....	2	5, 481	
Pleasant.....	3	8, 000	
Other sites (estimated).....			3, 345, 408, 000
Total.....			18, 940, 688, 000

These are all part of the Carson water-shed, which, with its branches, is fully 1,000 square miles in extent. With other projected reservoir sites on the Truckee and near Pyramid Lake, the engineer estimates foot up a total possibility of 133,229,968,000 cubic feet of water in storage for reclamation purposes in western Nevada alone. The area that can be served thereby is placed at 3,000,000 acres. If it were put at one-half, it would of itself, were it accomplished, redeem Nevada from poverty and political feebleness, and bring her both prosperity and power. The sage brush plains and table-lands that would be reclaimed are not now worth over \$2 per acre. It will take 20 acres to feed one broad-horned steer. If 2,000,000 acres were reclaimed in Nevada, every acre under water, without a foot of cultivation, would be worth \$15 per acre—that is, the area would be worth \$30,000,000. It would certainly not cost over \$7.50 per acre to reclaim. That would be an increase over cost and present value of \$11,000,000. When brought under cultivation, as well as under water, there is not an arable acre that would not be worth \$30 to \$70 per acre.

WILL IRRIGATION OPEN MINES AND MAKE HOME MARKETS?

It is objected already that agricultural production is overdone. This fallacious argument may be urged against land reclamation by irrigation. Those who may make it will surely do so without a full appre-

hension of the conditions. In the first place, people are going upon even the arid lands of Nevada. They will fill up these regions. The balance of the nation may condemn or ignore, but with a vast amount of unnecessary toil, just as our hardy miners unaided have once before exploited the wilderness, wringing the precious metals from savage nature and the hostility of the more savage Indian, so will the pioneer, rancher, herdsman, and frontier farmer yet make the desert "bloom and blossom as the rose."

The real issue is found in a question, and that is, shall we recognize facts and wisely aid in directing the energies by which they are wrought out? With this unappeasable pioneer movement will be found striking economic considerations.

The reclamation of our arid region means the opening of mines and the utilization on all sides of metaliferous deposits. It means new mines, mills, foundries, railroads, cattle farms, manufactories, towns, as well as fruit and grain farms. It means for Nevada the prospecting and opening of her 15,000,000 acres of mineral lands and her 3,000,000 acres of other valuable metallic and saline deposits. For every ton of alfalfa, there will be animals to consume; for every bushel of grain, mouths to feed; for every mine opened and every borax or sulphur deposit that is utilized, hundreds of laborers there and elsewhere will be set at work. Reclamation from aridity within our mountain area means vastly more than the raising of so many more bushels of grain. It means the opening of new and profitable industries, the laborers wherein will be the farmers' best customers. It is in this light that reclamation in Nevada especially presents itself.

WHAT NEVADA URGES ON CONGRESS.

The State has already added \$500,000,000 to the world's stock of precious metals. The world has been enriched thereby; but Nevada is the poorer, for the economic organization of civilization, almost passing her by, has not enabled her retaining even a moderate amount of this precious wealth. With aid to reclamation there will dawn upon Nevada a great future. From this standpoint the argument of her State board of reclamation commissioners is one that should be candidly considered. They addressed to your committee an argument on behalf of national aid, from which in part we quote without other comment or assent:

Many of the States and Territories in the arid region advance the following propositions:

"(1) The General Government to undertake the reclamation of the arid lands and provide for their settlement and sale.

"(2) That the desert-land law be so amended as to encourage individuals and companies to construct the necessary works for the reclamation of large bodies of said land.

"(3) That Congress grant to each State of the arid belt, or to each Territory, upon its becoming a State, all the irrigable land within its borders, held by the General Government, such States to be charged with the supervision of their reclamation, and with their disposal to actual settlers."

Of these, we favor the last. If the General Government feels that it would not be warranted in donating outright the money necessary to accomplish the desired end, then let it act as liberally as it can without detriment to the equity of other States, whose humidity is sufficient for all their requirements, and transfer in fee-simple to the State of Nevada all the lands in that State the title to which is now in the General Government and not otherwise appropriated.

Were these lands put in legal condition to be sold to actual settlers, firms, corporations, and syndicates, the money derived from such sales could be placed in a fund to be known as the "State reclamation fund," the sale of said lands and the control of said reclamation fund to be managed by a State board. The money accruing to this

fund could be used for the purpose of reclaiming such lands, and for the construction of storage reservoirs, canals, and tunnels; and thus induce the purchase by the farmer of lands upon which he would be guaranteed the necessary water for irrigation.

Thus all the irrigable lands in the State would be in demand by actual settlers, and money would flow in as fast as it could be utilized, and the fund would be found ample to do the work required.

Should the General Government be unwilling to make a donation of money, but will make this donation of land, the end would be accomplished, no doubt, as readily and thoroughly as by any other means.

The State has but a small tax-roll compared with other States. This board was only organized May 9, 1889. The State has appropriated \$100,000, so that this board could make a beginning. It is to the General Government that we most look for aid to carry on this great work. The title to most of the irrigable land in the State is in the Government, so that should the Government assist us it would at the same time benefit itself.

The fostering care of the General Government should be extended to all the States of the Union without distinction or discrimination. Nevada, as one of the integral parts of the Union, asks that this be done in its behalf now, at a time in its history when its needs are more pressing than at any period since its organization as a State. Its mines, which for many years were the envy of the world, have very materially fallen off in their production of gold and silver, and very many of the people engaged in that industry have departed to other fields. There now remains a population of probably 63,000. Of these the great majority are engaged in other pursuits than mining. The miner, having dug his treasures from the bowels of the mountains, had no further use for the country, and left behind him only the tiller of the soil, or, to speak more in the parlance of the great West, the rancher. This individual, with a persistence worthy of better success, has made productive every acre of arable land to be found along the water-courses of the State, or where, by small expenditure, land could be irrigated, he did so with much success, considering the capital invested and the opportunities presented. There being no more land available for farming in this way, if the area of producing land is to be increased, it must be done by a system of irrigation fostered by the General Government.

Of what that system shall consist, or how it shall be established, perhaps others more versed in such problems than ourselves should determine; but it must be done, or the State, which has within its borders thousands of acres of productive land, must remain as it is, poor in wealth and sparse in population. Such being the condition of things, can the General Government refuse to render assistance, or will it allow one of its sovereign States to languish, when a very small moiety from its treasure-house would place it in a condition of permanent prosperity, and add to that State's capacity for increasing its wealth and supplying homes for a greater number of inhabitants? Surely the policy of this great Government is broad enough, is expansive enough in its conception of what is beneficial for the good of its whole people, not to allow the parsimony of the huckster to stand in the way of aiding and fostering one of its great commonwealths.

The General Government can help solve this problem by aiding this struggling people in a manner different from the aid given to the people of other States. Nevada has no harbors within its confines to be sea-walled or dredged, nor does it ask for expensive light-houses to light the commerce of the world to its custom-house doors, nor has it a river requiring improvement or the expenditure of money to make it navigable, save, indeed, the Colorado, which in other years may be deemed a stream of sufficient importance upon which the Government may expend labor.

Nevada is particularly an inland State, and, not being in condition geographically to ask the Government for aid to be applied as other and older States do, it does not seem presumptuous or extravagant to ask for aid and assistance for a system of irrigation which, when carried out faithfully, honestly, and conscientiously, will people its confines with American citizens, and will create homes for the progeny of American citizens in a land where only educated labor and a pride in American institutions are required to make the most prosperous and happy people on the face of the globe.

THE PHYSICAL FEATURES OF CALIFORNIA.

The State is second only in area to Texas, being 620 miles in length north or south, with a width of 150 to 200 miles east and west, and a coast line of 900 miles in extent. It ranges in climate from the temperate to the semi-tropical and in altitude from 15,000 feet above sea-level at Mount Whitney to a depth below of over 320 feet upon the Colorado Desert. Its topographical features are all on a vast scale, imposing in appearance and often strikingly sublime in their beauty. Two great mountain ranges traverse the State from north to south. The Sierra Nevada has an average of 8,500 feet, while the coast range rises from 4,000 to 6,000 feet above the level of the sea. This vast range is, indeed, the cloud-gatherer of that region, and upon its summits and high peaks break and precipitate into rain and snow, the heavy burden of the moisture driven in from the Pacific by the trade-winds of that ocean.

Between these two ranges lie trough-like the great axial valleys of the Sacramento and San Joaquin. On either flank rise the tumultuous upheaval of the foot-hill regions. Shasta at the north, with its 14,440 feet of snow-crowned peak; Whitney, with its vast bulk in the center, and Mount San Bernardino with its 11,000 feet of rugged heights; occupying the extreme southern point of the Sierras. The great mountains look down upon grand plains, varied in character, broad in extent, and fertile in capacity, when touched by the quickening waters. Their height above sea-level, from north to south, ranges from 556 feet at Redding to but 30 feet at Sacramento, and 282 feet at Bakersfield. This is the area which has made California foremost among the wheat producing States, and is now rapidly advancing her to the first ranks among fruit-growing and wine-making regions.

THE CLIMATE AND RAIN-FALL.

The conditions governing successful irrigation in California are as varied as its topography and climate. The Sierra Nevada will show on its summits an annual precipitation of from 35 to 90 inches, or even more. The entire coast region with its numerous sunny valleys have for almost their whole extent, a rain-fall precipitated on its western slopes that is nearly sufficient for every purpose of farming and horticulture. But the eastern side of the same range south of San Francisco Bay is almost deprived of moisture. The mountain summits break the cloud-tides as they flow inward from over the ocean and compel them to discharge their moisture before it can reach the western limits of the San Joaquin plains. The 25 to 35 inches of rain-fall on the coast range, and the 40 to 90 inches on the upper Sierra, diminish rapidly until it falls from 22 inches at the head of the Sacramento Valley to less than 8 inches in the southern part of the San Joaquin. Below that it descends to less than 3 inches, while in San Diego County on its coast and eastern mountain slopes it will range again from 6 to 40 inches.

It is in this great diversity that the needs of California and the means of supplying them are both found. Storage in the mountains and good engineering in the way of distribution will add enormously to the irrigable area of this wonderful State. Every system of water usage and distribution can be found therein; its practices illustrate the primitive wastefulness common to early irrigation, and the remarkable economy in the use of water which intensive farming and horticulture have already produced in the extreme southern portions of the State. Nowhere

else in the world, except Madeira, portions of China, and Central Asia, has the "duty of water" been so thoroughly extended. As a consequence the price of land, the cost of water, and the security of crops have all grown in a steadily increasing ratio. Within twenty years land, which the owner protested against being taxed at 75 cents per acre, has been sold and is now selling at from \$500 to \$1,500 per acre. On the tract referred to more people are supported per acre and in greater comfort than elsewhere in the world.

The areas of fruit producing lands on which this occurs are small in extent at present, though they are quite numerous. These areas may be greatly increased by proper systems of water storage. They may be largely added to by the restoration and conservation of the underground supplies so steadily fed by the neighboring mountain drainage.

It is difficult to make anything like a close approximation of the reclaimable area of California. With the water "in sight," certainly 12,000,000 acres will be a low estimate. Water storage on a grand scale, such as the conditions warrant, will insure the reclamation of at least 20,000,000 acres. A large proportion of whatever area may be reclaimed will necessarily be devoted to the raising of products possessing a high market value. Its fruits are among the best in the world. It bids fair to become the successful rival of the oldest wine-growing and wine-making lands; its nectarine, prune, grape, and orange are already found in the markets of the world. The olive, fig, lemon, date, and other semi-tropical fruits are fast becoming of great commercial importance. Nearly all these products are the direct results of irrigation. They are all benefited by it when wisely directed.

The enormous addition to the wealth of the State and to the commercial prosperity of the whole country, which is the direct result of the high culture produced by irrigation, warrants a close attention to the united appeal of the people of California for such a survey of the public lands remaining therein and of the State's capacity for water storage as will insure to them that accurate knowledge which enterprise and investment require in the conduct of great affairs.

A careful tabulation of the assessment valuations in some of the counties of the State illustrates very forcibly the great increase of wealth produced by the practice of irrigation. It must be borne in mind that the figures given are not over 50 per cent. of the real values.

TAXABLE VALUES OF CALIFORNIA, 1879-1889.

GROUP No. 1.—Counties enriched by irrigation.

[Total taxable values.]

Counties.	1879.	1889.	Increase 1889.
Fresno	\$6,354,596	\$35,387,173	\$29,032,787
Kern	6,065,460	11,831,780	5,766,320
Los Angeles	16,368,649	84,376,319	68,007,670
Merced	5,208,245	14,146,845	8,938,600
Orange	2,517,700	9,270,767	6,753,067
San Bernardino	2,576,973	23,267,956	20,690,982
San Diego	3,525,253	31,560,918	28,034,265
San Joaquin	17,377,129	38,802,606	21,425,477
Stanislaus	6,232,367	15,594,003	9,361,636
Sacramento	18,416,338	34,464,174	16,047,836
Solano	2,651,367	6,906,007	4,254,640
Tulare	5,204,777	24,343,013	19,138,236
Yolo	10,177,427	20,911,325	10,733,898
Total	102,516,281	350,922,885	248,406,604

Orange County was not formed in 1879. It was then part of Los Angeles County. The ratio estimated for increase is on one part in 1879 to four parts in 1889.

GROUP NO. II.—*Counties increasing in irrigation activity.*

[Total taxable values.]

Counties.	1879.	1889.	Increase 1889.
Butte	\$10,743,426	\$20,730,252	\$9,986,826
Colusa	12,420,608	24,365,995	11,945,487
Leaven	1,230,764	2,527,449	1,396,685
Inyo	1,853,300	1,548,695	185,395
San Benito	3,947,728	6,332,911	2,385,183
Shasta	1,961,436	6,594,003	4,632,567
Siakiyou	2,651,367	6,966,007	4,314,640
Sutter	4,120,451	10,079,868	5,959,417
Tehama	4,199,998	11,901,253	7,701,257
Trinity	868,496	1,153,344	284,848
Yuba	4,293,630	7,046,316	2,752,686
Total	47,791,104	99,246,095	51,544,991

GROUP NO. III.—*Foot-hill counties partially irrigated.*

[Total taxable values.]

Counties.	1879.	1889.	Increase 1889.
Amador	\$2,468,642	\$4,281,969	\$1,813,327
Calaveras	1,871,850	4,315,461	2,443,611
El Dorado	2,312,590	3,879,887	1,567,297
Mariposa	1,295,048	1,849,641	554,593
Nevada	6,305,090	6,926,218	621,128
Placer	5,774,660	10,118,060	4,343,200
Plumas	2,115,173	2,309,441	194,268
Tuolumne	1,596,015	2,716,465	1,120,450
Total	23,739,268	36,397,142	12,657,874

—The bay counties of San Francisco, Alameda, Contra Costa, Marin, San Mateo, Sonoma, and Napa, present the following comparisons:

Valuation in 1879, a total of	\$333,146,966
Valuation in 1889, a total of	449,992,603

Making an increase of..... 116,845,637

These counties are partly affected by irrigation, to the direct extent at least of one-tenth part of the valuation given.

The remaining fourteen counties, of which nine are coast counties, show the following results:

Valuation in 1879	\$70,755,631
Valuation in 1889	156,039,572

Increase in ten years..... 85,283,941

Thus it will be seen that from 1879 to 1889 the taxable valuation increased from \$577,949,250 to \$1,092,598,297 an addition of \$514,649,047. Of this increase nearly one-half, or \$248,405,414, was made in thirteen counties, or one-fourth of the State, and is almost wholly due to irrigation. It may be fairly estimated that to the increase of irrigation in California and the rise in land values, etc., as a consequence, is due at least \$350,000,000 of the total taxable increase in valuation. That will be a marketable increase of \$700,000,000.

California, though foremost in the extent and variety of its irrigation interests, enterprises, and methods, is behind several other communities within the arid region as to its statistics and data. The operations of the State engineer's office have extended quite systematically

over a considerable portion of the San Joaquin Valley and the section south thereof. But a full, clear, succinct statement of the irrigated areas, number of ditch systems, and the mileage, with the cost thereof, is not accessible. From a number of authorities, your committee present the best average estimate obtainable, consulting therefor the State engineer's reports, the State board of trade, evidence offered by local witnesses, and county assessors' returns to the State board of equalization. The following is given as being well within the facts:

	Ditches.	Cost per mile.	Total cost.
	<i>Miles.</i>		
In the San Joaquin Valley, counties of Fresno, Merced, Kern, and Tulare	800	\$5,400	\$4,320,000
In the counties of Los Angeles, Orange, and San Bernardino	500	6,000	3,000,000
In San Diego County	36	19,613	706,068
In the remaining part of the State, twenty-four counties, where irrigation is practiced	1,700	640	1,128,000
Counting one-third of the mining ditches in the State as available and used for small irrigation, we have	280	3,188	921,221
Total	3,825		10,375,289

Without question the total valuation or cost is much below the true figures. Much of the data on which the estimates are based is taken from the assessors' returns made for the purpose of taxation. They can therefore be doubled. That will give a total cost of at least \$20,000,000.

The acreage is as difficult to arrive at with certainty, but it can be fairly and moderately stated as follows:

	<i>Acres.</i>
In the San Joaquin counties:	
In farm crops	1,000,000
In vines	13,000
In fruit trees	16,000
	1,029,000
In the southern counties:	
In farm crops	580,000
In vines	45,000
In fruit trees	85,000
	710,000
In the balance of State (irrigated):	
In farm crops	1,500,000
In vines	25,000
In fruit trees	30,000
	1,555,000

The total acreage wholly under ditch and now irrigated is fairly within the annexed totals:

	<i>Acres.</i>
In farm crops	3,080,000
In vines	83,000
In fruit trees	131,000
Total	3,294,000

If all the areas directly cultivated by the aid of natural sub-irrigation, etc., be added, the total area in California will certainly be not less than 3,500,000 acres. The point of interest, however, in these figures is the profitable character of such cultivation, especially in the matter of fruit-raising.

The number of fruit trees in the State has recently been estimated at 1,537,000. It is safe to assert that no other acreage of lands produces such large results as that occupied by these trees.

According to Statistician Dodge, of the Agricultural Department, it will be found that California possesses, of its whole area, 39.8 per cent. tillable, 24.5 in grass land, and 10.1 in woodland, while 25.6 is reported as being unproductive. This latter, however, is most valuable because it is the mining area. These percentages contrast with the whole Union as follows: 41.6, 11.5, 35.5, and 11.4. From the same authority we find the

	Bush. per acre.
Yield of corn is	28.5
Yield of wheat is	13.0
Yield of oats is	28.2

The average for the United States in the same crops is 24.2, 12.3, and 27.0. Certainly the golden State, the larger proportion of which a few years ago was considered of but little agricultural value, need not fear a comparison with any other country. A region in which the discovery of gold revolutionized both the commercial and political affairs of the modern world, and lifted the American Union into the front rank of monetary powers, and which now promises to become the richest of all agricultural and horticultural countries, has a large claim upon the General Government for a wise liberality in dealing with its public lands and the capacity thereof for the storage and distribution of water for reclamation purposes.

The legal questions involved in the beneficial uses of water have been strangely complicated in California. The Indian community system prevailed before and during the Spanish occupation, having been made useful by the missionaries, who obtained such great control of that population. The Spanish conquerors were themselves original dwellers in an arid region. When the State passed under the control of this Republic, such small portions of it as were cultivated owed their fertility entirely to irrigation. The modes of distribution were recognized as being properly controllable by the community. Water was public property. The American miner, with his new enterprises and enormous energy, created a whole code of laws in regard to the use of water. Its basis was the pioneer principle of first come first served, and that has been reproduced in our jurisprudence as "prior appropriation."

In forming a constitution, the people of California incorporated the body of common law. Judges and courts have construed the common law to mean that the doctrine of riparian rights necessary in England and in our Eastern States should be applied to the use and distribution of water to agriculture. It is easy to see that this conflict of prior appropriation and riparian rights must create considerable trouble. A large majority of the earlier irrigation enterprises, generally found in the foot-hills region, were served with water secured under the miners' prior appropriation laws. When the land owner on a stream demanded his riparian use of the flowing water, litigation, or worse, at once ensued. At no time, however, were the communities in the southern part of the State organized upon the old Indian and Mexican control, involved in this dispute. The prior appropriations had often, it is charged, attempted to monopolize the water supplies, not for their own or immediate use, but for speculative purposes, and as a lien upon the future. This gave some color of equity to the absurd demands for riparian rights, as at times these were sought to be exercised by small land owners against the large appropriators of

water and owners of great tracts of land. A few years since the supreme court of California brought the subject of riparian rights to a crisis by deciding in favor thereof.

As a result of this conflict, California has adopted a plan of co-operative or district control which bids fair to wisely settle all questions of water and its use, of irrigation, construction, and ownership, and of the methods and forces by which these shall be managed and paid for. This is embodied in several legislative acts known as the "Wright Irrigation District Laws." Under these acts the people of any drainage and arable area to be supplied by water from a common source, can, by obeying certain legal requirements, form themselves into an irrigation district, having a common seal, the right to sue and be sued, to make, own, and control irrigation constructions, to issue bonds therefor and pay interest on them, to levy taxes, to meet indebtedness and maintain works, to regulate the use of waters and decide the cost thereof to the farmer and consumer, to condemn lands and water rights, and in short to do all things necessary for a civil organization. These acts have all been passed during the last four years.

The constitutionality of the bonds to be issued have been assailed, but were affirmed and sustained by the supreme court. Since then, action under the district laws has been progressing quite rapidly. Some twenty districts had been organized at the time your committee was in California. The bonds of several had been successfully negotiated. Since then, at least ten more have been set in operation, the larger portion being in southern California. The amount of bonds involved ranged from \$6,500 in a San Bernardino district to \$3,000,000 in the district now forming in Fresno County. The area so far included will be over 3,500,000 acres. Probably one-sixth of this area is already irrigated. The effect of the policy embodied in these laws can be illustrated by a statement made in relation to the proposed Fresno district. The area embraced by it will be 600,000 acres. The amount of bond-age indebtedness to be incurred is estimated at \$3,000,000. Under the law a sinking fund is established, under which, at the end of the eleventh year, the bond redemption begins so that at the close of twenty-one years they will all be paid. These bonds are to bear 8 per cent. interest and the total to be paid will thus be over \$5,000,000.

Under the present system every water user first pays a royalty for the right to use of about \$2,500, and thereafter an annual rental of \$2.50 per acre. In condemning a ditch system, the district may under the law regard the royalties paid as compensation, to their full extent, of the original outlay. They will pay, therefore, for the ditches on the basis of their annual rental values. The area now cultivated there does not exceed 120,000 acres. The additional 480,000 that may be reclaimed by the proposed new works will have no charges to meet other than those legally established for the payment of interest, the repayment of the bonds, and maintenance of the district irrigation works.

As the area of reclamation grows larger each year, the annual taxation must necessarily grow much smaller to each individual. The cost under private or corporative ditch systems, will certainly exceed at the end of twenty-one years that of the district system, by the entire amount of royalty the private enterprises would have exacted. And when the district debt should be paid off, the small annual cost for maintenance and repairs would be all that irrigators would have to bear.

Your committee have been so impressed with the wisdom and equity of this plan that in the general irrigation bill reported by it, they have presented as a bounty to the people of the States and Territories inter-

ested, the privilege of taxing the public lands for the purpose of irrigation as private and State lands shall be taxed, provided the States and Territories legislate as California has done for the organization of civil bodies to be known as irrigation districts, to be located as far as practicable within a common drainage basin that can be supplied by water from one general source.

Your committee conceives that such a policy is the natural and normal accompaniment of legislation, which proposes to maintain the public property in and control of all natural waters, to secure access thereto of man and animal, to make inalienable the right of way for all proper distributing channels and works, to divide the public domain under a strict homestead law, and to execute a survey sufficient to segregate the irrigable areas from those which are non-irrigable, while indicating the proper reservoir sites for impounding the drainage and storm-waters, defining also the lines for distributory channels and estimating the cost thereof. This being done—a work too that belongs to the General Government, and involves no vast outlay—it is right and proper that the initiative in the construction of works, and the cost thereof, shall be undertaken by the local communities themselves.

Merely as individual or combined farmers the settlers would not have credit sufficient to do this. As a body corporate under the laws of a State or Territory, with power to do such things as the California plan has devised, even a small body of settlers on an isolated portion of the arid region, will be able to place their bonds upon the market and secure the needed capital. And yet, the lender of the money could never become the master of that community, because the waters thereof will remain public property, and the works by which they can be distributed will be under public control. The security and certainty that this will bring, will insure the solvency of the community and its industrial progress, thus making payment of interest and principal an easy task. Municipal bonds are everywhere considered the best offered in the money market.

ARIZONA AS AN IRRIGABLE REGION.

Crossing the Colorado Desert during the night your committee reached Yuma on the Colorado River. At this place, but a few miles above the head of the Gulf of California and shortly after sunrise on a September morning, its session was held in the open air while around it were grouped specimens of fine tropical fruits. Yuma has an elevation above sea-level of a little over 200 feet, and possesses almost the highest temperature in the United States. Its site is that of the delta of the Gila and the Colorado River mingled with low rolling sand-dunes and other detritus left by the receding waters of the river and the gulf. With its warm, rich soil of sandy loam, its clear and invigorating atmosphere, and the unvarying warmth of temperature that prevails, it is probable that nowhere else within our present public domain can such favorable conditions be found for the cultivation of semi-tropical fruits, sugarcane, cotton, hemp, and other fibrous plants, as in the valley areas adjoining this extreme outpost of our civilization.

Nor are these the limits of its products. Wheat yields largely. It was testified, too, that in one instance 483 pounds were seeded to 20 acres, was irrigated five times, and that it returned 52,750 pounds, which brought in the San Francisco market 50 cents per cental more than any other kind. Two crops can be raised annually. Barley produces from 25 to 40 bushels per acre, and a second crop of hay. Corn yields several crops yearly. Alfalfa will average 6 cuttings, at 15 tons

to the acre. Potatoes have returned a yield of 400 per cent. from the seed. A commissioner of emigration for Arizona has reported that—

The warm sunshine of the spring, summer, and autumn days causes the fruit in Yuma to mature early, and gives a delicious sweetness, flavor, and color to the orange, lime, lemon, and other citrus fruits, which they can not attain on the coast of the Pacific, where fogs dampen the fruit, mildew is produced, and dust coats both fruit and leaf. It is undeniable that nowhere upon the globe can a spot be found more favorable for the growth of citrus fruits than Yuma County.

The annexed table shows the time of maturity for certain products.

Strawberries.....	January 15.
Apricots	April 1 to 21.
Mulberries	April 14 to 20.
Figs	April 20 to May 1.
Grapes	June 1 to 7.
Water-melons, etc	May 15 to 20.
Peaches	June 15.
Pomegranates.....	August 1.
Lemons	September 15 to 25.
Limes	September 15 to 25.
Dates	September 1 to 5.
Oranges	November 25 to December 1.

Cotton has been tried for years with varied but satisfactory results, though only on a small scale. The report of the Yuma County committee declares that—

If watered regularly it becomes a large bush, and if properly pruned a tree, being in flower, boll, and cotton the year round. These bushes and trees have in instances borne steadily for fourteen years.

According to the same authority, the wild hemp is indigenous to the whole region—

It seeds itself annually, and immediately following the overflows of the Colorado River takes possession of every nook, corner, and open area, to the exclusion of everything else. It covers not less than 100 square miles in an unbroken stretch, commencing near the boundary line of the Gadsen purchase and extending southwards along the river to Hardy's Colorado, below the point where the rising tides of the Gulf of California force back the flow of the Colorado River proper.

Within our borders there can not be found a soil so uniformly fertile and so capable of varied production under irrigation as that of the valleys of the Gila, Salt, and Santa Cruz Rivers, in southern and central Arizona. The bottom lands are so easy of cultivation that it is not uncommon, after removing the brush and stubble, to pass once over the ground with an ordinary cultivator and then sow with grain or grass. Within three or four months thereafter large crops are harvested. Analysis of this soil shows its fertile qualities to be superior to that of the Nile earth. In these valleys, as elsewhere in Arizona, unmistakable evidence of ancient irrigation, prehistoric in date, has been found, covering large areas. In some instances, of late years, the Mormon and other farmers who have settled in central Arizona have again utilized the ditch lines of the former inhabitants.

It was estimated at Yuma that in the Gila Valley alone and within the borders of that county, under irrigation works in process of construction, 600,000 acres will be reclaimed. At the time of your committee's visit, grains and fruit were ripening in the fields that were seen.

Phoenix, the capital of the Territory, lying in the extremely fertile valley of the Salt River, was next visited. The testimony taken at this session will repay close study by all interested in the resources of our country. Mr. J. W. Murphy said:

The amount of land now under cultivation is, in round figures, about 100,000 acres; that is, under irrigation. There are in this county, in the Salt River Valley, about a

dozen canals, thirteen perhaps, with the combined capacity of about 2,000 cubic feet of flow per second. When the land is first irrigated, we estimate the duty of water here to be 60 acres per cubic foot, and requiring less water from year to year as it is irrigated until it reaches the minimum, when it will irrigate 150 or 160 acres. The canals now constructed would irrigate, in round figures, 200,000 acres.

He added that with the progress of irrigation, the filling of the land with water by percolation from flooding and ditches would render another 100,000 acres available to the present canal system. The canals in use and those projected and under way in that county will serve at least 200,000 acres without storage. A remarkable exhibit, by means of a chart Mr. Murphy presented to your committee, was made of the quantity of water in Salt River during the preceding twelve months. The first four months of the year the supply was only 400 cubic feet per second; during June and July it had about 100 miners' inches more. From the middle of November to the middle of May, which is the season of growing grain, the water was shown to be abundant.

For one six months it was not enough for the wants of the land, while for the other months the river carried more than 8,000 cubic feet, or nearly four times the amount that the present canal system can utilize. In the month of March alone, the river flows an average of 40,000 cubic feet, or twenty times as much as the canals can carry. These simple figures show the pressing necessity for a proper system of storage and they indicate the immense advantage to result from it. With an equal and accessible water supply all the year around there is no farm or fruit product that will not grow in the larger portion of southern and central Arizona, producing, too, from two to five crops per year. The same conditions are found in Pinal and Pima Counties. On the Pima Indian Reservation, and in the valley of the Santa Cruz and near Tucson, land will be found still under cultivation, that regularly produced crops before Coronado marched from the City of Mexico and the Spanish missionaries followed him in the sixteenth century.

The name of Arizona ordinarily brings to the minds of those who hear it the idea of a rugged, mountainous, mineral region, nearly all of which is arid desert and thoroughly irreclaimable. As a matter of fact, nearly 40 per cent. of its entire area is tillable, if water can be had, and to a degree, as your committee was shown, that is quite surprising. The problem of reclamation by irrigation must necessarily be solved by a system of large and small storage at high altitudes, yet in the southern portion of the Territory there are extensive areas to be reclaimed by the restoration through submerged dams and high line channels of rivers that are now lost in gravel and sand by sinkage. One example of this process is that of the Santa Cruz. It is estimated that 2,000,000 acres of fertile land can be so reclaimed. The sunken waters of the San Somoan plain or valley can also be restored to the surface and utilized for the cultivation of a great area. There are other extensive sections in which similar results may be obtained. Mr. Farish, commissioner of emigration, estimates the area of Arizona reclaimable by the present water supply at between 7,000,000 and 8,000,000 acres.

Lieutenant Glassford, of the Signal Corps, to whom your committee is indebted for a most intelligent report, estimates the valley lands of Arizona at from 6,000,000 to 10,000,000 acres, alluvial in character, and "unequaled in fertility and productiveness." He says:

That no portion of the Union presents such favorable conditions for the artificial catchment of water for agricultural or other purposes as does Arizona. In its great area, nearly double that of the six New England States, are presented physical features

peculiarly adapted to the construction and maintenance of an immense system of irrigation based on the storage of water by artificial reservoirs, and the supply of which it will be the endeavor of the writer to show is abundantly provided for by rain-fall.

Were it possible to obtain a bird's-eye view of the Territory, the observer would see spread out before him an area equaling Italy in size, consisting of a series of mountainous plateaus, ranging in height from 7,000 feet in the northern part of the Territory to a few hundred feet in the southwestern portion. Of these plateaus those of the north will be found interspersed with mountain chains and deep cañons. In some places volcanic cones rise over 5,000 feet above the plateaus, while cañon gorges are cut as deep below. To these characteristics the plateaus of the southwestern portion of Arizona present strong contrasts, consisting as they do of level valleys, mesas or table lands, gradually sloping off towards the Gulf of California. Some of these are basins of what have been, at comparatively recent periods, immense inland seas. In places the loss of altitude is so rapid that immense cañons have been cut by erosion through the mountain chains and plateaus, and immense basins have been formed along the water-sheds of all the permanent streams.

These cañons and basins are of great depth and area, and present unrivaled facilities for the construction of a system of artificial reservoirs similar to that established by the British Government in India, where the Himilayas present much the same characteristic features. The streams, which in the north flow through cañons whose precipitous sides tower thousands of feet above the surface of the water, as they reach the southern mesas roll sluggishly along, with barely sufficient fall to prevent their sinking in the sand.

It is in the valley along the latter portions of the rivers of Arizona that are to be found rich alluvial lands unequalled in fertility and productiveness.

The areas of these lands in Arizona are variously estimated from 6,000,000 to 10,000,000 acres, or an area surpassing all of Massachusetts, Connecticut, and Rhode Island, or Belgium, and nearly equaling Switzerland. The vastness of these areas can scarcely be realized from the mere mention of the figures, but their extent can be appreciated when it is remembered that the entire area of such land susceptible of reclamation on the Rhone in southern France is less than 400,000 acres; Spain does not equal this, while the famous deltaic provinces of lower Egypt possess but about three times this area, and India, the oldest settled of all lands, has but about five times as much as France under cultivation through irrigation.

Lieutenant Glassford says that the exhaustion of water in the lower levels has already commenced in many places. Storage, therefore, becomes a necessity, he adds, in order—

First, to widen the area of land possible to be reclaimed; and, second, to secure sufficient water during seasons of drought. Such storage being necessary to the general welfare, the question of the practicability of impounding water naturally arises.

The solution of this question is found primarily in an accurate determination of the depth of the annual rain-fall, with both the maximum and the minimum that may be expected in the district under consideration; also any peculiarities of its distribution. * * * Having reliable data upon the above points, the next subject of investigation is, what amount of water-flow becomes available, due allowance being made for evaporation, the selection of reservoir sites, and proportioning their size to the area of the catchment basin after a study of the drainage area in every particular. These latter questions are for the engineer.

It is quite clear that the Signal Service officers had no thought of the necessity of a topographical survey such as the Director of the Geological Survey declares is required.

By a series of tables and charts Lieutenant Glassford presents the annual precipitation in this Territory. It appears that in the southwestern and western parts of Arizona the rain-fall is extremely small, ranging from 2 to 6 inches annually—a record as brief as is anywhere presented in the world. Rising into the more elevated eastern half, central, and northern portions, the annual average of observations taken by the Signal Service ranges from 10 to 20 inches. Just over the line in Utah it rises to 36 inches, and at the head of the Gila River it is 33 inches. These figures are those of valley and cañon stations only; and for mountain summit and high plateau from three to five times more must be added.

There are two rainy seasons in Arizona—one in winter, one in summer. With the disappearance of the last snows the summer rains com-

mence. The winter precipitation never fails to flood the streams each year, and, continues Lieutenant Glassford, "Contrasting Arizona with the Pacific coast States, if she has not so great an amount of rain-fall it comes differently distributed, and experience may prove the dual rainy seasons of Arizona have not unequal advantages with the single but greater one of those States."

The present progress of reclamation is shown in the following table:

County.	No. of canals.	Length.	Area under ditch.
		<i>Miles.</i>	<i>Acres.</i>
Apache.....		24½	12,500
Cochise.....		51	8,800
Graham.....		60	35,000
Mari-copa.....	23	304½	194,400
Pima.....	36	52	30,000
Pinal.....	28	50	78,000
Yavapai.....		78	40,000
Yuma.....	10	120½	81,000
Total.....		740½	529,200

* In Pima Reservation.

These figures are entirely taken from county reports. The ditch system constructing in Yuma County will, when completed, have a total length of 241 miles and an acreage of 207,000. The total cost will be \$1,318,000, or nearly \$5,500 per mile. The canals under way in Maricopa County will, when completed, cover 404,900 acres and have a total length of 425 miles. Apache County reports 150,000 acres reclaimed, Pima County 2,500,000 acres, and Cochise 310,000 acres. Of the area "under ditch," about two-thirds are actually cultivated. One of the mistakes observed by your committee in the way of irrigation enterprise is found in the demand by active citizens, so far as heard before the committee, for the maintenance of large areas of land in few hands. The desert-land act policy was strongly supported by such witnesses, and they protested against its repeal, declaring that it is now impossible to organize irrigation enterprises upon the homestead principle, and the co-operation of the settlers in public lands under it.

Your committee believes such arguments to be fallacious and, as it has already shown, that the district system will, through community co-operation, result in successful reclamation on a large scale of our arid public domain. Owing to the want of railroad facilities and the circumstances attending the committee's inquiry in Arizona, it was found impossible to obtain the evidence of the smaller farmers therein, but all the facts go to show that the irrigation district system as projected in the bill presented for the organization and direction of a national irrigation survey is equally as applicable and beneficial to Arizona as it is to California or elsewhere.

UNDER-GROUND WATERS AND IRRIGATION IN TEXAS.

The session held at El Paso, Tex., was noticeable for its presentation of the international conditions which have arisen through the consumption of the Rio Grande water within the United States for irrigation purposes. The boundary and other questions involved by the shifting channel and conditions of that stream, have been already discussed. The irrigation aspect is, however, part of the international ques-

tion, inasmuch as the entire consumption of the river by our own people is proving destructive to the very life of the heretofore thriving farming communities, within our neighbor's territory, found along the western bank of the lower Rio Grande Valley. There are 50,000 Mexican people largely dependent upon irrigation, whose equal rights to the water have been solemnly guarantied by treaty. At the time of your committee's session, the Rio Grande was nearly dry for a distance of 500 miles.

This fact was due not only to the drought, but as largely to the use of the stream for agricultural purposes by the farmers of the valley of San Luis, and of the Conejos, within the State of Colorado. At least 150,000 people resident in New Mexico, Texas, and the Mexican State of Chihuahua are in danger of continued impoverishment by the conversion above of the living waters to the uses of the enterprising people of southern Colorado. This must go on practically unchecked, unless the running waters are supplemented by the storage of the storm and flood supplies of the region. The Director of the Geological Survey has at length and with great ability analyzed the situation in the Rio Grande Valley. He has also given his views of the remedial measures that must be adopted.

Your committee calls earnest attention to the evidence taken at El Paso, Santa Fé, and Las Cruces, bearing upon the situation in the Rio Grande Valley, which will be found in the third volume of the printed testimony. Western Texas, in its relation to reclamation, is divided, by the experts who testified, into three divisions. From El Paso to the one hundred and fifth degree of west longitude, and southward to the gulf, it forms a territory entirely arid in character, the rain-fall ranging from but 8 to 11 inches per annum. The one hundred and second meridian marks the eastern limit of that which is termed semi-arid, and from the one hundred and second degree to the ninety-seventh degree the sub-humid area is found. These divisions present very different conditions. The whole region, almost an empire in itself, finds place within its borders for all the problems in irrigation. Within the arid section, mountain and local storage with surface distribution, must afford the chief solution for its aridity. Besides the Rio Grande, the Pecos, Colorado, Brazos, San Saba, Neuces, Devil, and other minor rivers and creeks, will assist in the reclamation of an extensive area.

Except along the Rio Grande above Fort Quitman, and below from Laredo, irrigation has been considered almost impossible. A generation since a much larger area, however, was cultivated in the Rio Grande Valley between El Paso and Presido del Norte. At present some 18,000 acres are under cultivation on the Mexican side. There are ditches for 30,000 acres. About 6,000 acres are cultivated near El Paso and below; altogether from Western Texas, testimony was received showing an irrigated area of at least 150,000 acres, with ditches in process of construction to serve at least 75,000 more acres.

The semi-arid section includes a large portion of that remarkable tract known as the "Staked Plains," as well as the Pan Handle section of Texas. One of the most intelligent witnesses describes this region as follows:

Beginning at the Brazos River, which is at an altitude of about 900 feet, the country rises in steps toward the west. It is generally in the form of one plateau above another. So you proceed westward from Brazos River 20 or 30 miles, and you come to a bluff 200 or 300 feet in height, and above that is a plateau which extends 20 or 30 miles. The difference in altitude is from 150 to 300 feet in these plateaus. From west of the Colorado River the rain-fall is from 20 to 46 inches, with an average of 26, and in that country it has not been found necessary to irrigate, although it is

found advisable with the garden crops, vegetables, and things of that description. They have been benefited by irrigation. On the Concho near San Angela there are about 5,000 acres under cultivation by irrigation, and all the waters are obtained from the North and Middle Concho Rivers. About 50 miles north of San Angela that river springs out of the ground. Above that there is no river, but simply an old river-bed that extends all of 300 miles across the country into New Mexico. In the north branch of the Concho River, which is known where it crosses the Texas Pacific Railroad as the Mustang, irrigation is considered necessary. * * *

The Great Plain, where traversed by the Texas and Pacific Railway, constitutes a table-land about 65 miles in width, widening out northwardly, and extending into the Pan Handle several hundred miles. Its most southerly point is about 60 miles south of Midland, Tex. Its outline is well defined, its edges consisting of rocky bluffs extending for hundreds of miles, forming many bold promontories and shelters of coves. At some remote period of time its eastern edge was the shore-line of some great sea, which, as it receded eastwardly and southwardly, cut new shore-lines, converting the stretch of country between the plain and the Brazos River into a series of benches or table-lands, lying one above the other like the steps in a stairway, while the last step in the grand stairway, the eastern edge of the plain, has an altitude of 2,700 feet.

Before the creation of the Pecos Valley the plain seems to have been continuous with the eastern slope of the mountain ranges of New Mexico and western Texas. This would appear from the fact that the surface of the plain presents a gradual fall from the north and west toward the southeast, the altitudes from its western to its eastern edge being as follows: Douro Station, 3,100 feet; Odessa, 2,900 feet; Warfield, 2,575 feet; Midland, 2,780 feet; Marienfeld, 2,700 feet; the southern edge about 2,300 feet. Through some convulsion of nature a break in the strata was formed near its eastern edge, forming what is now known as Sulphur Draw, in Howard County, and probably several other fractures will be found north and west several hundred miles distant. This would seem to be indicated by the fact that the strata of the plain are continuous, and that water is usually found in abundance below the limestone, and that this supply does not seem in the least to be disturbed by either heavy local rains or long periods of drought. The water seems to come for a distance of hundreds of miles, and wherever the limestone is penetrated the supply is permanent. The local rain-fall seems to find its way through the various "draws" to the headwaters of the Colorado and Concho Rivers, and is eventually carried to the Gulf of Mexico, or passes through Red River into the Mississippi. The dark-colored "rises" of the Colorado River always indicate local rains in central Texas, and the "red rises" heavy rains on the Staked Plain. These rivers carry off the surface drainage. The underground drainage, namely, the waters under the limestone strata, work their way to the San Marcos, San Antonio, Guadalupe, Nueces, Sabinal, and many other rivers, which rise and fall at the same time that do the Rio Grande and the Pecos, both of which receive their waters from the mountain snows of New Mexico and western Texas.

The "draws" above mentioned seem to be able-bodied rivers that have retired from business. In times gone by they have carried great volumes of water, and have cut their way through solid limestone ledges, their banks being well defined to this day.

During heavy rains they resume business in a small way, occasionally drowning a flock of sheep that are feeding on their grass-covered beds. Generally the water is lost in a few days, having percolated through the sand to the limestone layer beneath, which is generally impervious. Most of these "draws" are filled with silt and sand blown in from the plain. They drain many hundreds of miles in area, and in many of them water in great quantity is found at a depth of 2 to 20 feet. Several could, without great expense, be again converted into flowing streams, carried to the higher lying lands, and be made to irrigate a considerable area. Mustang Draw, in Martin County, by the use of 5 or 6 miles of flumes, could probably be put to good use in this manner, as water in abundance is found at a depth varying from 2 to 6 feet. All the "draw" water will, of course, be surface water, derived from local rains.

The "underground water" is generally found at varying depth. At Marienfeld, on the eastern edge of the plain, at from 60 to 90 feet; at Germania, 10 miles west, at 45 to 60 feet; at Midland, 20 miles west, at 35 to 50 feet; at Odessa, 40 miles west, at 30 to 50 feet; at Douro, near western edge of the plain, none. In a few localities "joint clay," a water-proof material on which the "underground" water rests, comes close to the surface. No water was found, though this material has often been penetrated to a depth of 500 feet. A few of the surface wells are brackish and several salty, but generally the water is good. Several springs containing soda, sulphur, or gypsum water, as well as a few wet weather salt lakes, are also found on the plain. The only permanent running stream on the Staked Plain is "Running Water," in Dickens County, a bright, sparkling stream that suddenly breaks out of the ground, ripples over a pebbly bottom for a distance of 10 miles and then mysteriously disappears.

pears like many other streams west of the Pecos River, notably Leon Wells, Comanche Springs, Escondido, Limpia, and Toyah Creek, or the underground river near Castle Mountain, in Crane County, which is working its way to daylight by washing away the roof covering it, occasionally causing a part of it to fall in. A similar stream exists in the northern part of Crockett County, which was not known to exist a few years ago, though a recent cave-in exposed an abundant water supply 20 feet below the surface.

Nearly all the wells dug or bored in the "underground" water, under the limestone, show a tendency to rise above the point where first water was reached. In some localities a rise of 20 or 30 feet was observed, showing that the supply is under considerable pressure. Borings at Odessa have shown five separate layers or deposits of water to exist between the surface and the "joint clay" 100 feet below. Between the Staked Plain and the Pecos River is an ancient fresh-water lake basin, known as "the White Sand Hills," which is covered with numerous ponds of pure fresh water. The supply is permanent, and said to be inexhaustible. The railway wells at Monahans, in this locality, furnish an immense supply. Altitude, 2,620 feet. The wells west of this and to the Pecos draw their supply from the seepage of the Pecos River. East of the Staked Plain the water supply in wells is variable as to quantity, quality, and depth. In Howard County good water is abundant in the southern part, rather deep in the northern part, and brackish in the town of Big Spring. In Mitchell County, generally good at 30 to 50 feet, sometimes strongly alkaline. Several wells bored are capable of furnishing 9,000 gallons of water per hour continuously. At a depth of 200 to 300 feet super-saturated salt brine, claimed to be chemically pure, is found in inexhaustible quantity, and a fine grade of salt is manufactured. The Colorado River carries water in its bed nearly all year round. Its water here is said to be brackish and salty. A chemical examination will have to determine whether or not the water can be used for purposes of irrigation."

The extent of the underground water supply described by Mr. Roesler may be partly realized by the fact that, sparse as the settlements are, nearly one thousand wells, about one-fifth of which are artesian in character and nearly all of which come close to the surface, have already been bored within the regions described. The surplus of these wells is in many instances distributed by small ditches and flumes. Small storage basins are also maintained by them. The semi-arid section is remarkable also for the great springs which are found in many parts of it. The most notable of all these are those at Lampasas, which discharge daily about 1,400,000,000 gallons of water. There are many others of lesser magnitude, but all are remarkable for the volume of water that flows from them.

The products of western Texas are valuable enough to warrant the cost of a thorough examination of its water supplies. The Staked Plain will furnish abundantly the best fruits and vegetables of the temperate zone, ripening there earlier than elsewhere, and competing easily also with both California and New Mexico as to the quality and quantity of its vines and their products. The underflow problems on the Staked Plains and in the Pan Handle, as well as the spring region of south-east New Mexico, are of the greatest importance and will bear the fullest examination.

WHAT NEW MEXICO PRESENTS.

Two extensive river valleys bisect the larger portion of the Territory of New Mexico. The Rio Grande, as is well-known, passes through it from north to south. Within the New Mexican portion of that valley and its immediate streams there are about 100,000 people dependent upon irrigation and the land cultivated through it for their sustenance. East of the Rio Grande, rising in the northern portion of the Territory, the Rio Pecos carries a considerable body of water southward into Texas to its junction with the Rio Grande in that State. For two-thirds of its course in New Mexico it can be made to serve a large area of arid land. Reclamation has already commenced therein on an extensive scale, and some 30,000 acres are now cultivated and under

water. It is claimed that in the catchment basin of the Rio Pecos at least 20,000 square miles can be made available for irrigation purposes. A more moderate estimate, and probably a more correct one, places the reclaimable area in the lower part of the valley at 1,000,000 acres.

The ditch system partly completed and now in process of construction can supply water for 175,000 acres, and with a proper storage system will furnish enough to reclaim 400,000 acres. Your committee mentions this system, because, with the exception of one other in the northern part of the Territory, upon the Maxwell grant, it is the only one of modern character within the limits of New Mexico. Two years since there was not a house on the town site of Roswell; now there are 1,500 or 2,000 inhabitants. There was not a school-house within 50 miles; now there are several filled with children. Land that had really no market value is selling at from \$25 to \$75 per acre. There is no railroad within 150 miles of this newly-reclaimed region, yet it is testified that, notwithstanding this, all its products find a ready market at large prices.

The Rio Pecos basin and the region still farther east, is notable for its numerous important springs that break from the earth and flow down to the mesa, where their waters are absorbed and sink from sight again. They emerge from the earth with such volume and force as to show their artesian characters, proving without question that they come from the drainage-waters of the high and precipitous mountain ranges from the west. From all the evidence your committee has taken in regard to eastern New Mexico and northern Texas little doubt can remain that the whole region is underlaid with great bodies of water, some of which at least have the character of moving streams.

WATER FOR FOOT-HILLS AND MESAS.

West of the Rio Grande there is a region of numerous valleys heading into the mountains at considerable altitude with large areas of foot-hills, and towards the south an extensive mesa or table-land. No great bodies of arable land will be found there in any one section, with the exception probably of the San Juan Valley to the northwest. Yet there is in the aggregate a great body of irrigable land. The precipitation at high altitudes is quite large, and the storage facilities will be found ample. Small storage in the foot-hills can be availed of. The mesa land, which until recently had been given over to the wild steer and the horned toad, is now found to be of growing value for arable purposes. It has been proven at Deming and elsewhere that water can be obtained by bored wells at a moderate depth in volume sufficient to be pumped by wind mills not only for town use, but for gardens and small farming purposes.

The late Judge Bristol, formerly of the United States Court in New Mexico, testified that—

So far as my experience in Deming is concerned, it is this: I have bought town lots 25 by 142 feet that, with the exception of my dairy and barn and the rest, are planted in fruit trees. I have a large pump and an 18-foot well in connection with another man. We are supplying water for fourteen or fifteen families, and several gardens are being irrigated from it. My garden is most prosperous, as I give special attention to it. Fruits of all kinds and grapes grow to perfection; the Bartlett pear, and even the peach, the Early and Late Crawford. This year we have as fine a flavored peach as any coming from the Chesapeake Bay.

Before the railroad junction was made at Deming there was no water on this table-land, except occasionally when the water came down by flood. No water was known to exist there; but there is a region of country from 25 to 50 miles wide and 100 miles long north and south that we know of (and how much farther it exists we do not know) where if you dig down anywhere you will strike water at about 50 feet in in-

exhaustible quantities. To illustrate, at my place I have a powerful windmill, an 18-inch wheel (Holladay's). Each revolution of that throws out 100 gallons of water. You can run it up to 160 revolutions per minute. There are only 2½ feet of water in that well, and that quantity can not be lowered with that pump. It is so all over the plain.

In addition to that, in the water system to the north of Deming—Cook's peak mountain, which you probably know—there is one place where the water comes down every year from the mountains and passes through a range of foot-hills about 3 to 4 miles from the main chain of mountain. A perfect flood or river of water comes down there every year several times during the rainy season, and it has dug out immense excavations in the ground. These are filled with water, extending away out on the plain. It is a beautiful plain of the richest soil, and cattle from all over the country frequently, for several weeks at a time, gather in there. That would be a good place at which to build a reservoir, for it would afford accommodation for several thousand acres.

Judge Bristol declared that the opportunities for reclaiming lands and making homesteads were abundant; especially so on the lower mountains and among the foot-hills. As to the productiveness of the soil, he testified:

I simply say "water is king." Wherever water can be had or can be got on the soil it is wonderful in its productiveness. It is rich in all the elements of fruitfulness, even out on this barren plain that we have been calling a desert. Put water there and everything will grow in luxuriance. On the plains the greatest drawback at present, in my opinion, to successful cultivation is the strong spring winds which obtain in every country where there is no wind-break. As soon as forestry is cultivated here systematically, and trees are planted so as to break the prevailing winds, it will be a wonderful country for productiveness, providing you get water. The altitude of Deming is about 4,000 feet. It is on the first plain out of what we call the Mesa Valley of the Rio Grande. It commences on the bluffs of the Rio Grande and is a lovely plain all the way on into Arizona.

THE PRODUCTIVE CAPACITY OF THE TERRITORY.

Your committee was fortunate in securing at its Santa Fé sessions the evidence of men of the widest and most varied experience and ability. An engineer, Mr. Boyle, whose professional experiences in irrigation works has extended over Spain, portions of Hungary, the Danubian provinces as well as Australia, declared that New Mexico can "easily anticipate an increase of five times her present population within ten years if the storm waters that fall naturally be saved and used for the purpose of turning the water to the best advantage."

Speaking of the storm waters, Mr. Boyle said:

On the brightest days in July, August, or September, a storm will burst in the mountains, and the water will come tearing down the streams and practically run to waste. It often comes when the crops need it, but it goes to waste. If that water can be saved, it can be made advantageous instead of mischievous, and be made to support a large population.

The witness testified to the capacity of the soil, when supplied by water, to raise heavy crops. Wheat returns 30 and 35 bushels; oats, 40 to 45 bushels per acre. In northern New Mexico corn yields 20 to 25 bushels per acre. The onion crop of New Mexico, with proper cultivation, is finer than that of old Spain, and could easily be made to supply the United States. In the southern part of the Rio Grande, as well as in the Mesilla Valley, the climate and soil are admirably adapted to the raising of the finest fruits. In fair seasons, one acre of fruit land at Las Cruces will return an average of 20,000 pounds of grapes. Six to eight crops of alfalfa are cut per year, finding a ready home market at from \$12 to \$20 per ton. Mr. Boyle declared that the Territory and the climate is peculiarly adapted to the raising of the mulberry and the feeding of the silk-worm. He believes this pursuit will be a remarkable feature of industrial growth in that region.

It is to be noticed that everywhere, under irrigation, the highest quality of production is that which is most readily achieved with care and intelligence. Your committee dwells upon this point because it establishes the fact that the reclamation of our arid lands will not increase agricultural competition unduly; but, on the contrary, will broaden largely our supply of fruits and other products that must command high market values.

No statistics later than those of 1885 were presented to your committee. The superintendent of the Territorial census for that year says:

The amount of the lands under cultivation in 1880 was 5,053 farms, with an acreage of 237,392 acres which was improved. The valuation was \$5,514,399. The farming implements at that time were valued at \$255,162. The live stock at that time was worth \$5,010,800. The value of all farming productions at that time was \$1,897,771. In 1885 there were 10,511 farms, a gain of 5,458, with a value of farming implements amounting to \$1,595,370. The value of the farm products was \$2,914,984, an increase of \$1,016,910. That was on the farm products alone. The total land acreage of the Territory is 78,374,400 and the area for pasturage is 63,374,400 acres. Unoccupied pasturage amounted to 12,874,000. Public lands, subject to irrigation, amounted to 13,965,000 acres.

The opportunity for reclamation, if a storage system becomes available, can be illustrated in the basin of the Rio Grande above Fort Selden and Las Cruces, which is generally known as the Jornada del Muerto. This great drainage basin, larger than some States, contains at least 2,000,000 acres of reclaimable land. There is not in the whole basin, except the Rio Grande, which passes through its western part, a single living stream or spring. Water has been found at some points beneath the surface sufficient for the irrigation of several large and small ranches, but practically the whole basin is to all appearances entirely arid.

For the reclamation, finally, of this great body of fertile land there can be no doubt that sufficient waters can be obtained from the mountain and storm supplies which now run to waste, by impounding the same in storage reservoirs. The topography of this region is admirably adapted for reclamation, the grades and levels are such as to make engineering easy, while the lofty mountain ranges that surround it gather precipitation sufficient, if it can be utilized without interfering with any other basin, for all needed purposes. As elsewhere, each catchment area within the basin of the Rio Grande will be found to be dependent upon its own hydrographic resources, using the flowing stream as part only of a needed supply. The problems of reclamation in New Mexico deserve serious attention.

KANSAS SETTLERS AND THEIR DEMANDS.

Your committee's direct observation of western Kansas was confined almost wholly to the valley of the Arkansas, in passing westward to Colorado over the Atchison and Topeka Railroad. The evidence taken in the State and presented in the third volume of testimony covers, however, the entire area thereof west of the ninety-seventh degree of longitude. This includes about 14,000,000 acres, 12,000,000 of which are doubtless arable and fertile, capable of producing large crops of corn, small grains, vegetables, and grasses wherever water is obtainable, and the season of ripening is not affected by drought or the hot winds that prevail so injuriously over the great plains. The temperature of this region is continental in character, showing an average of fifty-three degrees, but ranging from fifteen degrees to one hundred and ten degrees. Great as is the diversity, the mini-

mum as well as the maximum ranges are not widely extended in time. This is the region marked on our school-day maps as forming a large portion of the great American desert. It is almost treeless, and its coarse grasses have for centuries past been trampled into a water-shedding thatch, by the constant movement of buffalo herds and other wild animals.

Within the boundaries of the State of Kansas the Arkansas is the only mountain-fed water-course. All others are streams of the plains, having their sources within them, and furnishing somewhat scanty supplies for 200 or 300 miles in length, until they are absorbed in either the Kansas or Arkansas Rivers. The altitude of these plains rises from 2,500 feet on the east to about 3,500 on the west at the base of the Rocky Mountains. Generally its grades are remarkably even. The upper Arkansas Valley, for example, will have an almost uniform fall eastward of 7 feet to the mile, while on either side of its divides north and south the gradient will be about 16 feet. These important physical features practically govern the reclamation problems of the section.

THE UNDERFLOW OR SHEET WATER.

An immense flow of water passes from the Rocky Mountains at certain periods of the year down the channel of the Arkansas River. That river, after debouching from the foot-hills below Pueblo, Colorado, spreads itself in a shallow stream over a very wide valley underlaid with coarse sand and gravel at a short distance beneath the arable soil. It is estimated that 75 per cent. of this great volume of water sinks into this substratum. It is locally designated as "underflow" or "sheet water." It was testified to as being at least 30 miles in width. Other estimates place its percolation as extending over a territory north and south of the river of at least 100 miles in breadth. Mr. J. W. Gregory, of Garden City, whose intelligent statements will be found in the third volume of testimony, declares that this sheet or underflow has a perceptible current. The same declaration was made in Texas in regard to the underflow water of the Staked Plains. Mr. Gregory said:

It would not be reasonable to suppose that it did not at least extend to the northern edge of the river valley and to the south side of the sand hills which skirt the river on the south, which would make an average width of at least 12 miles. What may be the average depth of this vast reservoir of sand and gravel saturated with water is not determinable from the slender data at hand, but it is safe to assume that it is more than 20 feet. That a steady current flows eastward through the porous strata of sand and gravel is a well-established fact and undisputed. It has been observed for years and by hundreds of people. In many wells the current is plainly perceptible, and in all any chance bit of wood or handful of chaff or leaves blown in by the wind floats to the east side of the well.

All these facts are of utmost importance to us, because they prove that underneath our feet a broad and deep stream of water slowly passes down the slope, compared with which in volume the visible stream is as an infant to a giant. Let us gather an idea of the capacity of this subterranean stream to supply us with water.

Carefully-conducted experiments, made in the past few days, show that a single square mile of this sand, 20 feet deep, contains about 209,000,000 cubic feet of water; enough to flood 19,200 acres of land to a depth of 3 inches. While it would be practically impossible to drain any given area of these substrata completely, it is well known that they yield up their waters with great readiness. The Garden City Water-Works well is but 25 feet in diameter, and penetrates the water-bearing stratum but 11 feet, and water can enter the well only at the bottom, the walls being of rock laid in cement, yet it will furnish 800,000 gallons of water per day. If, then, the half of these subterranean waters can be utilized to a depth of 10 feet over an area of 5 miles wide, enough water can be obtained to flood one-half of the land for 40 miles on each side of the river to a depth of 3 inches.

He added also :

My experience and observation, however, have convinced me that there is an abundant supply of water easily available that will not only irrigate the Arkansas Valley, but also the broad plains north and south of us that have been mentioned in your hearing by gentlemen from Scott, Haskell, and other counties. I refer to the supply of water which we know exists in this bed of sand that underlies not only the Arkansas Valley but reaches out to places on either side of it at a considerable distance therefrom. To undertake to utilize that by digging, as was suggested by one gentleman, to a depth of 50 feet, to bring that water to the surface, would cost so much that it would not be practicable; but by opening fountains along the Arkansas River, where the water is only about 3 feet below the surface, and taking advantage of the general fall of $7\frac{1}{2}$ feet to the mile, water can be carried to the highest land in this part of the country, excepting occasional knolls, and the percentage of that would be very small.

With other witnesses he urged strongly that the General Government should make a thorough examination of the whole matter, or, as he expressed it, * * *

Should systematize and start it. That it should make the survey, and also establish as many fountains or supply sources as are necessary to make a thorough demonstration of the practicability of the plan. We have these wells. We have within the present limits of Garden City a lake the bottom of which is below the level of the river, from which water runs the whole year round. That is a practical exemplification of this system, showing that it can not help but be a success.

Such a policy he declared (and in this he was supported by nearly all the witnesses examined in southwestern Kansas) would encourage the people, enable them to combine, and give certainty to enterprises requiring private capital. At Dodge City, eastward from Garden City, a large enterprise of the class desired by Mr. Gregory is already under way and promises great success. Since 1884, when irrigation began in southwestern Kansas, at least \$1,000,000 has been expended between Dodge City and Spearsville and their immediate neighborhoods in the construction of irrigation ditches for the purpose of taking the water from the river at the surface and distributing the same. The parties interested are now driving westward an underground canal in which to collect the sheet or underflow water and, by taking advantage of the uniform grade, will bring the same out into reservoirs from which it can be distributed through ordinary ditches.

The evidence taken shows clearly that there is no part of the Kansas plains region in which water can not be obtained at a moderate depth below the surface. Artesian wells are found in counties south of the Arkansas River, also north and west of Garden City, and at different points of the valleys of the Arkansas and of the Smoky Hill. In the extreme northwestern section the basin of the Republican fork of the Kansas, though much smaller in area than the Arkansas, is also, it is evident, underlaid with a great body of sheet water.

THE STORAGE OF LOCAL DRAINAGE.

Besides the possibilities involved in this supply, there are considerable opportunities for local storage of storm and surface waters. Some basins are quite extensive in area, but the larger number will be made by locally utilizing the ravines and "draws" that exist all over the region. The annual rain-fall reaches an average of 18 inches; last year the total was but 13. Even this would be sufficient to produce fair crops if it could be distributed at the right time, but, as all through the great plain region from north to south, the rain-fall fails the farmer during the weeks or days in which it is most needed. This is almost invariable, even though the year may have had more than an ordinary

share of moisture. It is this fact which renders it necessary, from the experience of the people and the observations of your committee, for Congress to continue the policy already begun in the preliminary investigation ordered into the existence, area, and character of the artesian and other subterranean waters of the great plains.

In the valley of the Arkansas, since 1881, the industrious settlers of southwest Kansas have made a vigorous effort to make their industry permanent by means of surface irrigation. About 150,000 acres have been so cultivated. Last year less than 70,000 acres were served. The soil will produce abundantly. Of the grains, grasses, roots, and fruits of the temperate zone, corn returns 40 bushels, wheat the same, potatoes 150 bushels to the acre; four crops of alfalfa can be cut per year when irrigated, giving from 8 to 10 tons per acre. The buffalo grass is everywhere vanishing and what is known as the blue-joint or wire grass is taking its place naturally. Fine orchards were seen along the Upper Arkansas. West of the ninety-seventh degree a learned Harvard professor declared in a special report, printed as part of the census publication of 1880, that no trees could be grown. In that portion of Kansas alone there are now 36,000 acres planted with thriving and growing forest trees.

SETTLERS AND SETTLEMENT ON THE PLAINS.

The Public Lands Commission of 1879-'80 reported that the arable portion of our public domain was nearly exhausted. This statement has been repeated in learned publications, such as the Encyclopedia Britannica, and by reputable writers on political economy. Ten million acres were then named as the limit of such arable area, yet it is a fact that since 1879 alone, west of the eastern limit assigned to the arid region, at least 110,000,000 acres have been taken up for farming and homestead purposes, and of this great area fully 50,000,000 acres have been located on the Great Plains.

The story of the pioneer settlement of this territory is full of suffering and pathos as well as of courage and success. One witness stated that he had lived in southwestern Kansas for more than twelve years and that in that time—

There have been two or three new crops of people that have come in. Many of those who did come went away. For instance, in 1879 quite a good many people came into this Western country for perhaps two or three years before 1879. Then there came a season when they left, and they continued to leave up to the fall of 1880 or the spring of 1881. In 1882 new people commenced coming and continued to come. They rushed here in crowds and continued to do so until 1887. Now they are going back again, leaving the country quite largely. They came here, they saw the rich soils and the splendid climate, and they started in to plow and plant. Then the rains came in the spring and the crops grew magnificently on and up to, perhaps, the 1st of July, and then there was no more rain. The hot winds destroy the crops, as a rule. There are some exceptions, but as a rule they destroy the crops. People always think the next year will be better and so try on and on two or three years and then give it up.

Mr. Gilbert, the civil engineer in charge of the underground canal at Dodge City, testifies that—

There has been quite a general moving out twice since I have been here, that is, within a period of about nine years. I think about one-third of the population each time. Those that remained branched out into the stock business and different pursuits and managed to hang along until another favorable season came. It is not practicable for a farmer to come here and make a living without irrigation. Every attempt has been a failure, and there have been two occasions in the last nine years that a large portion of the population have left.

Unquestionably, slow modifications are occurring in temperature and precipitation, owing to human settlement and cultivation of land. The Kansas testimony will be found full of interest in this direction. It is not meant that the rainfall has actually increased in quantity since settlement began, but that the changes produced in the earth by cultivation, owing largely to the drawing and shedding into the atmosphere through capillary attraction and evaporation of the waters contained therein, has had the effect of greatly increasing the evenness of local precipitation. With the continued cultivation of trees to serve as wind-breaks, at least there will be great and most beneficial modifications in their effects upon the hot winds now so injurious to the settlers on the plains.

It has been estimated that nearly 1,000,000 homesteads of 120 acres each can be carved out of the eight degrees of longitude east and west that are under consideration. If such results could be achieved it would mean a population of at least 20,000,000 persons to be supported therefrom by the varied industries that would arise. It is this slow modification, perceptible to the more intelligent of the settlers, that continues to inspire them with courage. Each migratory wave leaves behind in its ebb some of these hardier spirits, and so the region grows in spite of all suffering and disappointment. Is it too much for these people, carving new commonwealths out of the wilderness, to ask of their Government such an inquiry into the physical facts relating to their water supplies as will enable them to understand the degree of dependence that can be placed upon them?

Your committee thinks their demand a reasonable one and believes that Congress will sustain these views.

There is one suggestion broached by a witness at Garden City, which is worth while to emphasize by quoting. This witness said:

There is another thing I wish to say: I believe that the homestead law is based on the wrong idea. It should be based upon improvement and cultivation and not based upon residence alone. As the law now stands, a man comes out into this country, settles on the land, and builds a little sod cabin. With \$50 or \$100 of improvements he can not cultivate much. Therefore very little of the land is cultivated, and very little improvement is made. The country is covered with a little short Buffalo grass; that is a sickly vegetation, at its best, and three or four days of hot sun and dry weather will ripen it. The country is all just the same as though it were bare, and there is no vegetation to keep the air cool. The hot wind that blows over the crop is manufactured right near the crops. As you well know, a field of corn will be burned a rod or two into the crop and the balance will be nice and green. You take trees and plant them out on a piece of land 40 rods wide and they will make a little stunted growth. Break up 40 acres and plant them in the center of that 40-acre piece and they will make a fine growth. Now, if this law required a man to break up 140 acres, even if he did not cultivate it, it would cover the field with vegetation and there would be less hot wind. If you break a piece of prairie land, and can get away from it, you can afterward see it miles off by reason of its greenness, while all the land around it is parched and dry.

This suggestion was made elsewhere and at different occasions during the progress of the inquiry, and your committee considers it of importance and practical value.

RECLAMATION AND IRRIGATION IN THE CENTENNIAL STATE.

Irrigation in Colorado presented to your committee an interesting study. The first colony enterprise was organized and brought to success within its borders. The controlling force of corporation enterprise has there been modified, largely for the public good. No riparian issue has ever been raised to disturb the legal and common-sense aspects of

reclamation by irrigation. Colorado, through its courts as well as legislation, was the first State to recognize the miner's law of prior appropriation of water, as applicable with restraining interpretation to beneficial use in agriculture. Embedded deeply in constitution and statute, Colorado has recognized as fundamental the principle which your committee sought to embody in the bill reported—that is, the public nature and property of all natural waters lying within a region so arid that agriculture can not be carried on without the artificial conservation and distribution of the same.

Colorado has applied two qualifying interpretations to the doctrine of prior appropriation. One is, that the beneficial use which is the basis of such appropriation of water must necessarily be limited in its application by the wants of all other subsequent users; that is to say, that an appropriation made in days when necessity was unknown could not be construed to deprive the members of a growing community of their pro rata share after the first or prior appropriator had received his portion. The other is, that water being public property, the carriers of the same by means of ditches or other methods can claim no ownership or possession in the water itself. Their remuneration is derived from the transportation and distribution through the channels they construct to the lands on which it is needed.

Colorado from the first has logically declared that water companies are common carriers, and their legal status to be the same as that of railroads or other transportation corporations. The State, following these lines, early assumed a direct supervision over the whole subject. Its area is divided into six irrigation divisions which are again subdivided into sixty-eight water districts, each one of these representing in the main a distinct drainage or irrigable basin or region deriving its supply from some common source. Associate Justice J. C. Helm, of the State supreme court, testifying before your committee, stated that that court announced the doctrine of prior appropriation before it was incorporated into the statutes, declaring it to be the common law doctrine for their conditions. Such a decision requires two acts to make it valid; that is, the diversion and use of water for a beneficial purpose. Referring to the custom of Colorado courts and “decreeing” a certain amount of water for a certain district, Judge Helm said:

METHODS OF WATER CONTROL.

Our statutes divide the State into irrigation districts, as you know, and under the statutes the district courts, which are the highest courts of record next to the supreme court, adjudicate what we call the priorities of right. These districts are generally arranged with reference to the natural streams, and if from the principal natural stream in a district one hundred ditches have been taken, the court proceeds in the method pointed out by statute to determine the dates at which each of these appropriations were made when the ditches were constructed; the size of the ditches; their capacity; the degree of fall of the water. Then a decree is entered which declares these dates, declares these facts, and assigns the priorities to these ditches in accordance with the dates of the diversion. Under our views the use must follow the diversion within a reasonable time. These decrees assign to these ditch priorities in accordance as I have stated with the dates of the diversion, and, as I have said, the use, of course, is connected with that diversion. The question of reasonable time goes according, of course, to circumstances. But the proposition is, that if the ditch is dug with due diligence and the water is applied reasonably soon the priority relates back to the date of the commencement of the ditch. Possibly a statute might be framed which would declare how soon use must follow diversion, but so far we have no such general statute, and the court has not laid down the proposition. It would remain a question of fact to be determined at each particular case. This decree also determines the quantity going to each ditch. The decree of a given district must be considered, and the quantity of water assigned to each particular ditch or to all

the ditches taken together in the aggregate would constitute the quantity in use or the quantity assigned. If there is not water enough, those having priority under the decree would get it first. In each district there is an irrigation commissioner whose duty it is to superintend the distribution of water according to the decrees or the court. The governor appoints a commissioner for each water district.

ORGANIZATION AND MANAGEMENT OF WATER COMPANIES.

The questions relating to ditch ownership, organization, management, royalties, and rentals were clearly and judiciously stated by Professor Carpenter as follows:

There is a mutual company class and one class of companies that are formed to sell water. The mutual companies generally divide the ditch into shares—each person taking a number of shares depending upon the extent of his property underneath. The amount of water he gets from the ditch depends in that case upon the number of shares he has in the ditch. They divide it according to the number of shares. In the second, or stock companies, they generally sell the water, or water rights. "Water rights," as a term in this State, is generally taken to mean the supply of water necessary for 80 acres of land. In those companies they agree, if they have water, to give a definite amount of water, not exceeding a certain quantity. There are two general types of contract; first, a contract made by the company with a man to sell him a certain amount of water on certain conditions, provided he keeps up his payments. The second is a water deed, which is given to the man in exchange for the first, when he has carried out the provisions of the first contract. These contracts represent the provisions of nearly all companies that I have been able to secure deeds of.

In most cases farmers have a perpetual water right. Under a few canals they rent water. The prices for perpetual water rights vary with the different canals. In the San Luis Valley they pay \$400—that is \$5 an acre for the perpetual right. In the northern part of the State the Larimer and Weld Company have a different price. In the case of the North Poudre it is \$15 an acre. The North Poudre also has a charge of \$1,200 for a perpetual right. Another prevailing price is \$800, and another one is for \$1,000. The Arkansas Valley Company charges that much. That is for a perpetual water right, but all subject to an assessment for maintenance. The farmers are assessed for running expenses. Very frequently there is a provision that an assessment for maintenance shall not exceed a certain amount, say \$10 for 80 acres, for ordinary assessments. Then they very frequently have a provision that in case of a very extraordinary difficulty in that ditch, or extraordinary repairs, they may be subject to a certain maximum assessment, \$20 or so. The ditch company is the judge; but they very rarely charge an extraordinary assessment, even when they have extraordinary difficulties. But for the larger ditches that does not seem to be enough (with the present amount of irrigated land under them) to maintain the ditch. If all the land were under cultivation that would perhaps be enough. In other ditches the assessment is more, depending somewhat upon the local conditions or the difficulties the company think they may meet. In the case of the union ditches, the associates keep the ditches in repair, and the prices are less, because generally the ditches are smaller and the expense of maintenance is less. A small ditch runs itself almost. In the small ones it is perhaps from 5 to 15 cents per acre per year for maintenance. Each large ditch has a superintendent whose business it is to distribute the water. The stock owners appoint, or in the case of a mutual company, they have a meeting as every company would have, and make their own arrangements. The superintendent is an officer of the company, and he distributes the water according to the farmer's holdings in the ditch. In the smaller ditches where they have plenty of water, each man takes all the water he wants.

A DEMAND FOR STATE OWNERSHIP.

Colorado has not yet grasped the idea embraced by the district system now being organized in California. To meet the evils and inequities which have grown up in the State as elsewhere, under the corporation system, an agitation has sprung into existence on the part of the combined farmers which makes a demand for State possession and ownership of all water ditches and their laterals.

The State being a large owner of land has already found it advisable to construct ditches in certain localities in order to make its lands valu-

able. One of the leaders of the agitation for State ownership declared that—

The farmers have come quite generally to the conclusion that there must be a radical change in the control and management of the water. Most of them approve of State ownership. They take the model of the United States Government in controlling the delivery of the mails, which is the best possible service at the least possible expense. The Government in some form, whether the United States Government or the State government, should control the water. Whether any given Territory should be segregated into water districts, or be controlled as a whole, is a matter of detail. The point is that the water, as far as it goes, shall be justly distributed by men who have no financial interests at stake; men who are simply there for the sake of the service they are to perform. That would be the consensus of opinion in this State as to the delivery of the water to the farmers. * * *

It has been heretofore, and is to-day, attempted to hold so-called water rights as independent and separate things from the use of the water on the land. The ditch owners assume to say, "We will sell you a water right and give you a piece of paper"—an alleged deed showing that that is your right. Yet a man may sell out the land to another who is ignorant of the water laws, and the second purchaser is thereby left without water. In fact it has been so arranged that a man has had to pay twice for those so-called water rights, in first buying outright and in after buying over again from the same company. But worse than that, the buying of any water right at all is paying a company that has really done nothing.

The constitution of Colorado declares that the water is dedicated to the use of the people. The doctrine, as I conceive it, should be that when a piece of land is once cultivated with water, the State is interested in seeing that it should never be deprived thereof. Of course, everything should be done to compel the economy of water. While a man's selfishness impels him to get all the water he can, there is but one way to prevent a large waste. If the water were measured accurately to each man as he uses it, and at the end of the season it were ascertained what quantity he had actually used, then he would pay for the actual amount used. In that case the question for him to decide is, "How much does my crop actually need?" He would at once cease to waste the water. In other words, the duty of water would probably be increased to at least twice the amount at present. If the State had the matter under control so that the consumer would pay for what he actually used at the time he paid his taxes, there would soon be universal satisfaction with the system of water distribution.

ISSUES MADE FOR AND AGAINST WATER COMPANIES.

The great complaint in Colorado arises from the payment of royalties to ditch companies, also the alleged sale of water which carrying companies can not deliver. The farmers through their spokesman, asserted that royalty is really an imposition, giving them nothing but an alleged right to water for a certain area of land. They further assert it to be a bond wrung from their necessities, for which no adequate return is made, because they assume also that the annual rental per acre is a sufficient remuneration for the carrying companies. They mortgage their lands to pay these royalties. In scant years they are deprived of sufficient water. The great desire to obtain royalties, they claim, causes the companies to contract to deliver more water than they can control. Those who have already none must therefore suffer or obtain the same from the ditches unlawfully, and they do obtain it, because the sustenance of themselves and families depend thereon. As a result, the courts are full of litigation, fines and punishments are frequent, and great bitterness is being engendered. Accusations of large profit somewhat wild in amount were made before the committee.

A prominent lawyer of Denver testified at some length as to the difficulties encountered by the ditch companies. Mr. Platt Rogers said that—

The statutes of Colorado and the decisions of the courts take the position that a ditch owner is nothing more nor less than a common carrier, and that he is simply entitled to make a charge for the carriage of the water. In other words, it is declared by the constitution and enforced by repeated decisions that the water is the

common property of the people of the State, and that therefore it is incapable of private appropriation; that it must be put on the land for the purpose of use, and that the owners of the ditch perform no function except to carry it from the stream to the place where it is used. For that they are entitled to pay, and for nothing else. That being so, the county commissioners are vested with authority to fix the charges in case there is a difference between the user and supplier of water. In other words, the rule already applied to railroads is made to apply to ditches. I think that in actual operation this is an obstruction to the building of ditches for the revenue to be derived from the ditches simply as such. My experience is that the large ditch companies in this State have expected to get their revenue, and, in fact, have got revenue, from the fact that they are the owners of large bodies of land lying under the ditch, and that, save for the ownership in that land, the ditches would have not been constructed. So that if the question were presented now in respect to the use of large sums of money for the building of ditches, the right and power being in the people or in the county commissioners, that right and power would act as an obstruction, because the companies have not the right of making such rates as they think will compensate them for the construction of a ditch.

All the evidence presented in relation to the conditions prevailing in Colorado sustain the position advocated by your committee in regard both to the public nature of water as property, its inalienability from the land, the need of a proper engineering survey and examination of our arid public domain, and the advantage to be derived through district organization and public ownership of irrigation works.

THE AREAS IRRIGATED.

Colorado is as notable for the physical data it offers in relation to irrigation as it has already been shown to be in the legal aspects thereof. From a report made since your committee's visit, by Prof. L. G. Carpenter, of the State agricultural college, there is shown to be the following:

Approximate areas "under ditch" in Colorado.

	Area.	Total area.	
	Sq. miles.	Sq. miles.	Acres.
Division I (Platte Division):			
Platte Valley, below the Poudre	283.21		
Platte Valley, above the Poudre, including Bear and Clear Creeks.	551.64		
St. Vrain and Boulder Creeks	294.50		
Big and Little Thompson	134.22		
Cache La Poudre	393.54		
Total from South Platte		1,657.20	1,060,608
From North Platte in North Park		101.23	64,787
Division II (Arkansas Division):			
East of Huerfano River	489.08		
Cucharas	94.40		
La Veta and Apache	84.17		
Upper Arkansas and Fontaine	106.91		
		774.56	495,718
Division III (Rio Grande Division)		1,564.00	1,000,960
Division IV (San Juan Division), including Dolores, Mancos, Pine, Florida, La Platte Rivers		185.00	88,406
Division V (Grand River Division)		210.00	134,460
Division VI (Bear and White River Division)		110.00	70,400
Total		4,552.00	2,913,273

By this table the total amount of land under ditch in Colorado at present is not far from 4,500 square miles, or 3,000,000 acres. The amount of land actually irrigated can not be so reliably estimated at present. It is much less than that under ditch.

Professor Carpenter estimates the total irrigated as not over one-third. This is apparently below the actual results. State Engineer Maxwell

presented at the Denver session the following figures as a careful statement of the area east of the Rocky Mountains:

Divisions.	No. of districts.	Miles of ditches.	Acres.	
			Under ditch.	Actually irrigated.
No. 1 Platte	14	2,097.86	1,126,800	631,086
No. 2 Arkansas	18	942.30	440,240	116,047
No. 3 Rio Grande	8	1,033.68	566,097	250,208
Total	35	4,044.84	2,163,137	997,340

In the three eastern divisions there are also one hundred and sixty-two reservoirs, with a record capacity of 5,319,939,788 cubic feet, capable of furnishing one acre-foot of water to each of 122,199 acres. The total number of ditches, large and small, in the State is estimated at 2,000, and their mileage at 5,000. The duty of water is placed at 1.45 cubic feet per second for 80 acres. In some sections it is over 100 acres, however.

West of the range in the Grand River, Mesa County, Uncompahgre, and other sections, there were 110,000 acres actually irrigated. The estimate of E. S. Nettleton, the leading engineer of the State, reaches for last season, one of water scarcity, to 1,300,000 acres. From the various enterprises now in progress and for which it is claimed water can be obtained, the area under ditch in the present will not be less than 4,000,000 acres.

THE AREA THAT MAY BE RECLAIMED.

It is estimated that there is at least 32,000,000 acres of arable land east of the Rocky Mountains and within the borders of Colorado. Of course, no one indulges in the expectation of fully reclaiming that great area by even the most extensive system of storage; but it is quite probable that with the growing economy in the use of water; with the changes that are sure to come in methods of distribution, supervision, and ownership; with the storage system that is already begun and projected, and largely, too, by the application of mechanical means for the recovery to the surface of the waters beneath, that the reclamation of one-third of the area named may in the near future be reasonably anticipated. In the older irrigated portions of eastern Colorado the duty of water has been so much increased that 1 cubic foot now serves 100 acres, where recently it served but 60. Much evidence was given on this subject.

RECOVERY OF WATER AFTER USE IN IRRIGATION.

The system of district supervision, as well as the intelligent oversight of the State engineer, is yearly increasing the public knowledge of the effect of water on the soil, of its capacity to serve agriculture, of the immense proportion of the great mountain precipitation which passes into and under the earth's surface, and of the action and results of evaporation and seepage from stream and ditch. The close series of observations made in regard to the latter show some striking facts. They have shown already that a large proportion of the water used for

irrigation, slowly but surely returns into the channels below from which it was taken above. Streams that constantly ran dry on the plains a few years since are now found to have considerable water in them. Many springs have broken out east of the cultivated area. The gauging of the Cache la Poudre, for example, has been so systematically carried on that the engineers are enabled to state the volume of water returning to the channels below, from the 260,000 acres irrigated, with great precision.

It is claimed that this fact should put an end to the fears entertained in communities east and south of Colorado, through which run water-courses that rise in the Rocky Mountains, of a final diversion from them of their proportion of such flowing streams. But it is evident that the processes of return by percolation are very slow indeed. As a result, even if the assumption is correct of a future fullness of volume, there must be great temporary deprivation in adjoining States and Territories through the present and rapid increase of irrigation in eastern Colorado.

UNDERGROUND SUPPLY—ITS CHARACTER AND POSSIBLE EXTENT.

The soil of the arid region when first irrigated and cultivated is of the thirstiest character and absorbs great bodies of water. As it fills up, however, the observations that have been made and the facts that present themselves seem to justify the theory that plant life while consuming the water distributed over the surface, also draws thereto the drainage waters that pass below. In this wise a compensating balance may be struck, and in the course of time the natural drainage of the irrigated fields fed from both surface and below, will be found to return to the streams an amount equal perhaps to that they have consumed.

One of the most interesting propositions, sustained, too, by reasonable illustrations, is seen in the use already established of pumping machinery for bringing to the surface the water found in the gravel beds below the alluvial. In twenty counties of Colorado, lying east of the base line which runs through Pueblo, which does not embrace the foot-hills, there are 25,000,000 acres of land, four-fifths of which is of an arable character could water be obtained. It is asserted by those interested in the use of mechanical power that at least one-fifth of the total area is underlaid by an ample water supply, to be found within a few feet of the surface.

The valleys of eastern Colorado have all been formed by denudation; upon the bed-rock have been deposited by the streams gravel and sand, which is now filled with water. This stratum ranges from a few inches to 64 feet in depth. At the base of the foot-hills it consists chiefly of large bowlders, decreasing eastward from large stones to coarse gravel and sand. At the foot-hills the water-bearing strata is narrow, but it widens out for many miles as the valleys are reached and the grade of the streams becomes less. The enormous snow-fall of the mountains melting as the season advances must under even ordinary conditions pass into the earth at least one-third of its entire volume. Under varying conditions a large amount is lost below. It is the recovery of the water that promises the greatest and most beneficial results throughout the whole plains region eastward to the line of industrial humidity. The problems involved in these suggestions have been almost wholly overlooked or ignored by the hydrographic engineer and the geologist. Practical men, whose experiences and suggestions are so often made the jest of the savant, have not, however, overlooked them.

CAPACITY OF THE GRAVEL STRATA FOR WATER STORAGE.

Your committee dwells on the facts presented in the Colorado testimony (vol. 3) bearing upon the questions here stated. That evidence demands careful study, because in these facts, your committee believes, the way opens to a reasonable solution of many reclamation questions in the area lying between the ninety-seventh and one hundred and fifth degrees of west longitude. Mr. West, one of the most intelligent witnesses heard at the Greeley session, stated that—

The amount of water that may be stored in a cubic foot of sand or gravel, when fully saturated, has been ascertained by careful experiment to be as follows: Fine sand, 2 gallons; coarse sand, $2\frac{1}{2}$ gallons; sand and fine gravel, 3 gallons; coarse gravel and small stones the size of hen's eggs, 3.6 gallons. As a cubic foot contains 7.5 American gallons, it will be seen that very large gravel beds contain fully one-half water. Water is found in all the dry creeks and the valleys adjacent thereto in northern Colorado, east of the mountains, at varying depths from 2 to 20 feet. Actual tests have been made verifying this matter. * * * As investigation goes on, the area of land known to have underground reservoirs of water at a nominal depth from the surface is largely increased.

In addition to the 5,000,000 acres already assumed to be reclaimable by mechanical means in pumping water from below, it is estimated by the same authority, that in seven of the southern counties 300,000 acres more can be added.

There is much waste land in these counties. The depth to water averages from 6 to 25 feet and the supply seems enormous, entire rivers and creeks flowing into the sand and being lost for surface irrigation. Fuel is plentiful and cheap in these counties, coal costing from \$1 to \$6 per ton, according to locality. In New Mexico it is estimated that 1,500,000 acres can be reclaimed by mechanical power. There is much waste land in that Territory. The depth to water is usually from 10 to 50 feet and the supply of water near the surface seems very large. Fuel is plentiful and usually cheap. Coal costs from \$1 to \$6 per ton. Mesquite is used for fuel in some localities.

The same conditions and means are found and can probably be applied to large areas in other States and Territories. Another witness testified to his observation of conditions that re-enforce the suggestion already made. He said:

Another feature of the country adjacent to us is, that east of us is a system of sink-holes. You understand, I suppose, what is meant by that. Those have for their substratum, you might say, beds of sand. I am satisfied, from my experience, that those sand-beds can be made places for the storage of water. Our experience shows that wherever irrigation is employed springs break out where under ordinary circumstances they never flowed, and they frequently flow along into the winter, sometimes throughout the winter; and if these sand-beds were infiltrated with water I am satisfied that it would constitute a constant source of supply to the stream below, because water in those sand-beds finds its way to the stream. They generally overlie a stratum of alluminous shale which is impervious to the water, and it will flow out to the stream and constitutes a continuous flow.

Professor Carpenter, speaking of the same problems, also strengthens the theory of mountain drainage supply. Referring to the Republican basin in northeast Colorado, and its water, he said:

Its supply must come from the mountains, I think, indirectly. It can not come from the seepage of irrigation in that immediate vicinity. The water from the mountains must outcrop at various places, as we know it does at the head of the Republican River, and so on through Kansas. The Republican River rises in the eastern part of the State entirely away from the mountains or any perpetual water-shed or water supply in the sense of rains or snow, yet I believe it is a perpetual stream and they are irrigating from it.

STORM WATER SURPLUS AND EXTENT.

State Engineer Maxwell presented charts and statements to your committee in relation to the surplus waters that are now entirely lost. The facts that he and other witnesses gave bear strongly and show

clearly the necessity of storage facilities. They illustrated the peculiar hydrographic phenomena of our mountain sections. For example, Engineer Maxwell showed that on August 1, 1888, Clear Creek, Arapahoe County, discharged 8,700 cubic feet within two hours. The ditch takes but 1,131 feet. There was consequently lost 6,500 cubic feet per second of time, or in all 47,296,800 cubic feet. That is sufficient water to cover 1,086 acres 12 inches deep. Coal Creek, in the same year, discharged on one occasion in three hours over 963 cubic feet per second. On another occasion the same creek discharged in a short time 6,076 cubic feet per second. The amount of water lost in the first instance was 10,453,720 cubic feet, or sufficient to cover 240 acres with one solid foot of water. In the other the loss was 43,747,200 cubic feet, or sufficient to irrigate 1,004 acres with acre-foot of water. These isolated instances, as to the extent of the storm and surplus waters, show what may reasonably be expected in that direction when fuller survey and investigation is had, and the energy of the people with the aid of capital shall be united in the construction of storage reservoirs.

THE PRODUCTIVE VALUE OF THE STATE.

Colorado is especially adapted to the production of the grains, grasses, and roots of the temperate zone. The eastern foothills are found valuable for the fruits thereof, while in the valleys of the western slopes the finer fruits, such as grapes, apricots, etc., can be profitably raised. In the San Juan, to the southwest, the semi-tropical fruits and crops will be cultivated successfully on the mesa and valley lands.

Of the area of Colorado, 98.2 per cent. is not in farms. Of tillable land the area is 23.8 per cent.; grass land, 29; woodland, 3.8; and the unproductive is rated at 43.4 per cent. Colorado stands as to productivity as follows:

	Bushels per acre.	Average.
Corn.....	27.7	24.2
Wheat.....	19.6	18.8
Oats.....	31.7	27.0

From 1884 to 1889, the public domain lying within the borders of Colorado has been occupied to the total of 9,155,561 acres. This is within less than 1,000,000 acres of the total amount of arable land which, in 1880, the Public Lands Commission declared was the whole arable area left for settlement. Again, it is evident that the specialists do not know all the facts or are able to accurately forecast the future.

AS TO THE ECONOMIC VALUE OF SMALL HOMESTEADS.

The farmer witnesses before your committee were nearly all disposed to advocate large farms. On the other hand, business men interested in the welfare of the State, loaners of money on farm mortgages, ditch owners, and others advocated the division of the land into small holdings. One witness declared emphatically that he believed—

The homestead law ought to be amended so that one person could not acquire more than 40 acres of land under its provisions in the arid region. My reasons for this position are, first, the average farmer could make more money farming 40 acres of land

by irrigation than he can a larger amount. The homesteader is a poor man, generally. He must borrow the money, at a very high rate of interest, with which to improve his land and live upon it, to provide himself with the necessary farming implements. He must go in debt for water, and wait for the harvest season for any returns from his toil and expenses. If he has 160 acres, his great desire to improve it all causes him to buy too much water, too much farming machinery—in short, it causes him to shoulder too much debt. His taxes and expenses are greater, and he is not capacitated to farm so much land, and farm it well, and the result is his harvest is no greater than it would have been had he carefully cultivated a smaller tract. * * * The law ought to be changed so as to make the cultivation of the land for a given time requisite to obtain title, rather than occupancy. Land that is cultivated in the arid region must have water. If the farm is once put into a state of cultivation, and has a water-right attachment, there is no danger but that it will be occupied, and forever after be a home for somebody. But under the law as it now is, a homesteader may put upon the land a trifling building, ever so small and worthless, sleep there occasionally, but in reality live elsewhere, and in a short time have title from the Government, called a homestead, which, in reality, remains wild land. The spirit of the homestead law is violated, there is no home upon the land; it is used entirely for speculative purposes. I am not stating an exceptional case. In many localities it has been and is now the rule to obtain what is miscalled a homestead in this way.

The evidence of Thomas F. Dunbar, whose business is that of loaning money and estimating land values for mortgage purposes, is so clear and forcible on this that he is quoted at some length here:

As a rule, I do very little in non-irrigated lands because we think them of very little value. Very few crops can be grown with any certainty on what we call dry lands. I confine my loans almost exclusively to lands under ditches and with ditch rights attached. * * * In the best counties, Larimer and Weld, land that is well improved and well down in grasses, under a ditch that is reliable and with perpetual water-right attached to the land, go as high as from \$50 to \$75 an acre, the very choicest; the second class from \$25 to \$50; that is, for loaning purposes. They could be sold and they do sell for that. Taking the new places, like the San Luis Valley, with perpetual water-right attached to the land, the advances on loans on mortgage average from \$3 to \$5 per acre. The highest advances made in the State will probably range at \$25 per acre. The medium advances, about \$10. The lands that can not be irrigated in the San Luis Valley are only good for grazing, and are not worth over \$1.25 an acre. Lands under one of those ditches without a perpetual water-right to enable the acquiring owner to get water would be worth from \$5 to \$6 an acre.

Under cultivation, continued Mr. Dunbar, its value depends thereon. He said:

The trouble is with a man living on 160 acres of land, carrying a mortgage on the whole and only cultivating 25 or 50 acres. The holdings are too large. We want smaller holdings of land and better use of what we have. There should be close tillage, so as to make every gallon of water tell on every square yard of ground. They can not do it now. A man could well support and bring up his family on 40 acres if thoroughly well tilled, where he could do the work himself. He attempts to grab 320. The consequence is he has only got 10 per cent. of his land producing anything, or, if he does attempt to cultivate it, he has to do so by expensive and inefficient labor. He goes to an expense for machinery and gets no result. Instead of plowing 10 inches deep, he plows 3 inches deep and goes over a large area. Forty acres is enough for a man to live on with his family. Of course, he can not do that by raising wheat and oats. He should have fruit, vegetables, hops, and so on. There is a large demand for hops. I know a man making \$300 or \$400 an acre on hops, and a man can easily make \$100 an acre on alfalfa. To get the best results a man must have a small area and cultivate closely and have a supply of farm-yard manure. Our soil here is very heavily charged with mineral matter and is very deficient in manure material. He must grow a variety of crops. We do not want men to raise a large surplus, but we want large communities and to have the land more closely cultivated, so as to bring our population nearer together, and have them produce everything that men can and need to live upon. That is what brings wealth into any State. All our immigration comes from non-irrigated districts. Everything here is new to such immigrants. The conviction is forced on my mind that a man is better off with 40 acres thoroughly cultivated than 160 acres half cultivated.

My observation is that a man is better off with 40 acres in the arid belt with every foot of it well cultivated, and his crop thoroughly attended to, than he is to have 160

acres skimmed over. The man with 40 acres in the arid belt well cultivated will make more clear money in the end. I will lend him 25 per cent. more money on 40 acres of well cultivated land than on 160 acres half cultivated. The men that have a section of land have to have machinery and all that. Then a man's water-right will go farther on a small farm. His supply of water would have to be all put on at the same time.

Leaving Colorado your committee held sessions at Cheyenne, Wyo., and Ogallala, Nebr., closing at the latter places the extended and exhaustive field of inquiry that it has conducted.

WYOMING AND ITS HYDROLOGY.

The area of Wyoming embraces four distinct drainage systems or basins. The Rocky Mountains proper, passing from Colorado northward through the middle of the region, forms on its eastern slopes the important drainage division of the North Platte and its tributaries. North of this section and east of the Big Horn Mountains lies a region abundantly watered by streams that form part of the Yellowstone system. They only need diversion to supply the agricultural wants of that rich and fertile section. Westward of the same range the important valleys and bench lands of the Big Horn and Wind Rivers form a third division. Fed by the precipitation falling on the western slope of the continental divide, is a considerable part of the Snake, Green, and Bear River basins belonging, by their configuration, to the great interior region of our western mountain system. This makes a fourth hydrological division.

There are over four hundred mountain streams within the borders of Wyoming, and the mountain area from which they flow contains at least 35,000 square miles, 22,400,000 acres. The Territorial engineer, Elwood Mead, claims as a moderate computation, that the annual precipitation on these storm-condensers and moisture-storers will average not less than 3 solid feet of water. This estimate contains 60,000,000 acre-feet; an amount sufficient, at the rate per annum of 1 acre-foot for 80 acres, to irrigate 10,000,000 acres of land. Major Powell has made an estimate as high as 12,000,000 acres. The precipitation is there, the mountains offer unequalled opportunities for storage, the numerous water-courses can be rendered available with added artificial facilities for full distribution, and the land will present, with its broad levels and fertile qualities, an easy work for the engineer and ample return to the farmer.

The agricultural possibilities of Wyoming are almost as great as its pastoral facilities, and they have been considered unequaled by the ranchman and cattle-raiser. It is worthy of note as an illustration of the development of the new West, that even in the territory that has been almost wholly given over to stock-raising on a large scale, the necessity for systematizing that business has compelled a resort to irrigation on a large scale, in the cultivation of grasses as well as grain, in order to secure permanent feed.

IRRIGATION RESULTS.

The ditch statistics of Wyoming are remarkable for the growth they exhibit in that direction. The great extent of mileage and the very large area "under water," does not, however, testify to a large degree of arable cultivation. The water is used most largely to secure and increase the pasture needs for the great herds maintained thereon.

From Engineer Mead's report, made to your committee, the following table is given:

Irrigation development by districts.

District.	Total No. of recorded ditches.	Total length as stated.	No. of claims, with statement of length omitted.	Total capacity as given.	No. of ditch claims, omitting statement of capacity.	Total acreage watered as given.	No. of ditch claims, omitting statement of acreage.
1*	648	1,322,385	39	5,911,584	48	482,434.00	80
2	327	582,793	31	6,649,844	53	379,164.64	62
3	282	817,419	91	3,644,078	72	395,563.00	114
4†							
5	502	996,398	32	10,422,760	57	440,540.00	50
6	124	196,955	46	1,556,325	36	58,162.00	55
7	322	518,240	50	1,658,905	96	108,976.78	95
8	182	312,410	52	3,096,487	79	35,396.00	96
9	49	91,430	1	342,000	25	42,480.00	3
‡	7	11,905		136,800		4,180.00	
Total..	2,438	4,249,985	242	20,881,728	466	1,946,875.42	564

* Seven reservoirs additional.

† District No. 4 omitted because of incomplete record.

‡ Unorganized district.

Of this area of nearly 2,000,000 acres not more than 80,000 acres are under cultivation other than for stock purposes.

WATER LEGISLATION IN WYOMING.

In legislation for the regulation of the water supply Wyoming has very largely followed the example set by Colorado. It has had the advantage thereby of being enabled to provide against some of the demonstrated failures of the older community. But it has nevertheless copied its fundamental error, in permitting the control and rental of water as a matter apart from the land which it is designed to serve. Engineer Mead shows the nature of the records required in the following statement:

Under the Territorial laws the owners of the ditches are required to file, in the offices of the county clerks of the various counties, a statement showing their capacity, location, acreage watered, and such additional facts as are required to make a complete record. As there is no penalty attached to a failure to comply with this requirement many ditches are not recorded, probably five hundred in the whole Territory, and, owing to defective blanks used at first, many that are recorded have made incomplete statements, so that it is impossible to state accurately the area reclaimed. The present extent of irrigation development is an extraordinary record when it is remembered that it is principally the work of the past ten years. In extent the irrigated area exceeds the average of the land farmed in each of the New England States and should forever put at rest the cavil or question as to the ultimate wealth and greatness of this Commonwealth. If the pioneers in this work can, unaided and under great disadvantages, produce such results, what may not be accomplished through the intervention of ample capital or of State or national aid?

The constitution of the proposed new State enforces and broadens even the doctrine that water is public property subject to supervision for beneficial uses only.

REQUEST MADE FOR A LAND GRANT.

The session held at Cheyenne, in Wyoming, was notable also for the vigorous presentation through Engineer Mead of a carefully prepared argument and demand on the General Government for the transfer in

support of irrigation development of the public domain remaining within the borders of Wyoming. The same policy was suggested in Nevada; but in Wyoming evidently it had been carefully considered by leading citizens, who put Engineer Mead forward as their representative. In stating this position Mr. Mead said:

I want to say first what has been the development of this Territory before I give the plan. We have found it impossible and unsatisfactory to combine under the present system of land owning. The result has been that people have combined and built a ditch to water merely their own claims. We have in this Territory to-day probably three thousand ditches built, though there are on record only two thousand five hundred and fifty. The great majority of those are individual ditches. Each settler who went on a stream built an individual ditch to water his own claim. Another settler came and did likewise. I can show you on the office maps twenty-six ditches on one stream in one township. The Territory is charged with a division of water between those several claimants. Take a stream 80 miles long and undertake to divide the water between eighty claimants, and you will understand the difficulty. That plan is immensely wasteful of water and of everything. It is very difficult to maintain those ditches. The average expense of watering land by that system is over \$10 an acre. If we could have highland channels that would water those areas, it should not cost half that much to get the water on the land, and more water would get on it. My idea is to turn this land over to the Territory or to the local government, under such regulations as will secure its final disposal to actual settlers, and the Territory could put the companies under such restrictions as would secure ditches, and could also manage the work of their being settled by actual settlers. We would then have a system that could be intelligently planned.

* * * * *

This would be my plan: To turn these lands over to the States. The proper procedure would then be, either for the State or the National Government to locate these canals on the streams, say where they ought to be. Then it can make a close estimate as to the cost of construction, and what it would cost to operate the same. I would then allow private capital to build that ditch, and would permit the companies to charge (to have an agreement in the first place that they might charge) a fair rental for the water, and I would provide for that to be continued subsequently, if necessary. Then in regard to the land, I would do this: I would permit the ditch companies, perhaps, to have the management of the settlement. I would make them colonization agents, but I would have the State itself pass the title to the settler. I would not make any title absolute until I knew that it was a bona fide settlement; but I would put the settlement of it in the hands of the ditch companies. They will have the greatest interest in securing settlement. What the ditch company needs is an assurance that the land will be settled when the water is there. They want to be in a position, as soon as the ditch is built, to run it the next year to its full capacity. If they can do that they can furnish water at a much less rental.

In answer to a question relating to the regulation of the price of water Mr. Mead further said:

Land upon which there is no ditch in this Territory will have a price varying from 15 cents to \$1.50 per acre—I mean grazing lands. If you construct a ditch over such land, say a large ditch, so as to make it certain that there will be a considerable settlement there, that land is ultimately reclaimed, and the result will be that the land will enhance in value from the construction of that ditch from \$5 to \$15 per acre. Suppose a ditch company goes in at the present time to build that ditch and make it possible for the pre-emptor or homesteader or any one with a timber claim to go and file on the land, settle down, and get a title to the land without in any way contributing to that enterprise of the ditch company, it makes it possible for him to reap that unearned increment.

INTERSTATE WATER USES.

Wyoming, like Colorado, contains the sources of important interstate water courses. Governor Warren was emphatic in expressing the opinion that the use of water in Wyoming, however fully it might be consumed for irrigation purposes, would not eventually injure any adjacent State or Territory. He said:

No matter how we would use the water in Wyoming, I can not conceive of any system that would not benefit the surrounding States and Territories. It is possible that some evidence may have been adduced, or may be offered, showing that the

Platte River has less water east of here on account of irrigation. In answer to that, I should say that if it is so, it is because the water is largely taken out in the first year's irrigation of large tracts of land. If you take out a stream and distribute the water over a great area, it will show less water the first season for a few miles below, but, it never fails, later, to irrigate sufficiently with less water. There is one stream I know of that has been controlled by one company for eight or ten years. Originally that was a stream coming from springs that would run down about 50 rods, probably, and sink again. At many points that stream would be totally dry for three months in the year. They have taken out the water, and at the present time the water is not used at all upon what was formerly irrigated land, but is spread on the hill side. What was formerly irrigated is now ditched, and the water is taken from there. That is a surplus of water which is carried down the hill, so that the purpose is to drain out the water down below. I say this very frankly that, if I were a citizen of Nebraska or any other State, and had interest in the waters that flowed from Wyoming, I would be glad to see irrigation practiced just as extensively as the water would warrant. In other words, I would like to have the waters kept back and stored in the land rather than have them come down in the flood time. There might be slight suffering, except on some large stream where very large operations could be conducted, but as a general thing the operations on any one stream would not be felt. When the soil was once filled it would operate to make the land need less irrigation.

FERTILITY OF SOIL AND PRODUCTS.

Ex-Governor John W. Hoyt, in reply to questions asked of the crops produced by irrigation in eastern Wyoming, especially on Laramie Plains, said:

I simply know that the experiment has been made of producing the different cereals, wheat, rye, oats, and barley. The work was begun five years ago and proved successful; in some places even without irrigation. The experiment was not a large one, covering only perhaps 10 or 20 acres, but it was very satisfactory. Potatoes are grown in the garden plats of the city of Laramie. The product is very fine and the yield very large. A good deal of snow falls upon the mountains there. The streams have their sources in the Medicine Bow range, and the streams very often are flooded and overflow at the banks, so that a very large amount of water could be saved at that season of the year that now goes to waste. If that could be stored (and there are natural basins in which it could be stored) the waters of the Big Laramie would be able, from a reservoir supply, to irrigate a large body of land. There are about 200,000 acres of beautiful land lying between the Big and Little Laramie Rivers, very rich, productive soil, which would produce very handsome crops of nearly every sort except Indian corn, if watered. There is already a ditch there taking some of the water of the Laramie, but there is a large quantity of water still in reserve, and there are natural basins in which the surplus could be stored when not needed.

I have no question as to the possibility of producing fine crops there. The specimens of wheat that I saw must have yielded 40 bushels to the acre, and they have claimed 50 bushels. Oats are produced in very large yields. Wheat is not grown to any considerable extent there; none of those crops, I ought to say, are grown to any considerable extent as yet. The water supply has not been sufficient and the persons who own the lands and would be encouraged under favorable conditions to commence the cultivation of crops have been delaying on account of the condition of the water supply.

I may not be able to furnish exact data, but I hear of 300 and 400 bushels of potatoes to the acre. The vegetable crop, I ought to say, is very remarkable. The root crops are very fine. There is a beginning also in the cultivation of small fruits and even with apples, so that many of our people are beginning to think of planting fruits. I am speaking of the Laramie Plains especially.

The chief agricultural area of Wyoming at present is found in the northeastern portion of the Territory, in the counties of Johnson and Sheridan. One of the witnesses said:

In the two counties there are 6,200,000 acres. By preserving the water I have no doubt that it could be increased at least five times what it is at present. There are about 450,000 acres at present under irrigating ditches. There is water enough in an ordinary season. There has not been this season, on account of the light fall of snow last winter. The present supply, if properly distributed, would irrigate at least 640,000 acres. I think that by the construction of storage reservoirs in the Big Horn and preserving the waters, 2,000,000 or 2,500,000 acres can be irrigated, counting both sides of the range in Johnson and Sheridan Counties. On the east side of the range

the soil is a black sandy loam, very rich. On the western side of the range it is principally a red gypsum soil, very deceptive to look at, but very rich in the production of crops, being mixed with the loam. There are 45,000 acres now under ditch, and between 300,000 and 350,000 acres are already practically irrigated. The other portion, 100,000, is not yet fully reclaimed. It is mostly the second or third bench or mesa land. In 1887 there were 1,729 acres cropped to wheat; 7,816 cropped to oats. The amount cropped to barley was quite small, perhaps not over 150 or 200 acres. The oat and wheat portion has been increased very nearly if not quite 100 per cent. since that time. The barley area has probably been increased to 1,000 acres. About one-half the balance of the land was, in 1887, cropped to hay. That has been increased about only 75 per cent., owing to the lack of facilities for getting the products out of the country on account of the long distances from the railroads.

THE SUBTERRANEAN SUPPLY

A remarkable artesian basin, chiefly so because of the high altitude of its location, is found within the plateau known as Laramie Plains. This location is much higher than the artesian belt at Denver and vicinity. It has development sufficient only to indicate its possibilities. The water of the wells is chiefly used for domestic and stock purposes, but use has also been made of it in irrigation. The Territorial engineer regards this and other evidences of artesian waters as of considerable importance to future development.

THE WATERS OF WESTERN NEBRASKA.

The last session was held at Ogallala, in western Nebraska. The people of that region have been like those of the Dakotas and Kansas, denying the necessity of irrigation. The increasing drought of the last three years, as well as the varying nature of the local precipitation, has awakened them to the need and advantages to be found in the artificial application of the water to the land. Prof. L. E. Hicks, who occupies the chair of geology in the State university, was the principal witness at the Ogallala session. He declared that State lines ought not to control water-supply storage or distribution, that each hydrographic basin embracing a river or other large stream, and its confluent should, so far as water is concerned, within the arid region, be under distinct regulations and not affected entirely by the needs of the particular community within whose territory the principal water course may take its rise. He illustrated his argument by references to the North Platte, a stream which is not yet used up in Wyoming where it finds its source, as its confluent, the South Platte, has been in Colorado. A very large area of land could be reclaimed by it in both sections, but to do so would require engineering operations on a large scale. This would need to be carried on by a great corporation, or by State or National authority.

Between the North Platte and the Niobrara River in northern Nebraska, there is a great table-land at a moderate elevation. The distance between the two streams is about 100 miles. The soil on this plateau is very fertile, the subsoil is considered unequaled for the retention of water. The opportunities for storage, according to Professor Hicks, are very good. The eastern limit of the arid region in Nebraska will form an irregular curve, the center of which would be at Fort McPherson or $100^{\circ} 30'$. The northern point would touch 91° and the southern rest at 110° . The valley of the Niobrara contains a large body of land lying very favorable for ditching and in every way available for irrigation.

The stream carries a large volume, and at such rapidity that the old French voyageur called it "the water that runs." In the same section will be found the White and Loop Rivers, with considerable tributaries, all available for irrigation purposes.

In southwestern Nebraska the Republican River, one of the most notable streams rising in the great plains, forms with its northwest Kansas area, a considerable hydrographic basin. It has apparently no mountain drainage supply, unless from beneath the soil. The local rain-fall, to all appearances, furnishes its flow, which is quite considerable. All through the Republican Basin a large supply of water can be obtained at short depths below the surface. The rain-fall, in the region reviewed by Professor Hicks, is sufficient, with a small artificial supply for the farmer's use. In eastern Colorado 12 inches of water, artificially applied, is required. In western Nebraska the amount needed will range from 2 to 8 inches, according to proximity to the eastern line of aridity. The professor was emphatic in support of a thorough irrigation survey. He put the amount of land in the western half of Nebraska at 40,000 square miles, of which total 22,400,000 acres could be reclaimed by the use of water storage and distribution. Quite a remarkable artesian water belt was also reported.

A CHANGE DEMANDED IN FARM POLICY.

A number of farmers testified before your committee at its last session. They all declared in favor of irrigation, and gave evidence as to the insecurity for farming purposes of the average rain-fall. The Nebraska testimony, like that in Kansas and Dakota, strongly emphasizes the need on the part of the settlers upon the great plains of the cultivation of more limited areas than is the case at present. The pioneer enters homestead and timber-culture quarter sections, and probably adds a pre-emption claim. He has but a small amount of capital; the season is good, and the rain-fall abundant. With these advantages the large area entered tempts him to extend farming operations. Paradoxical as it seems, a successful harvest almost invariably causes the pioneer to run into debt for stock, seed, and machinery. Then comes drought and failures, and the farmer soon becomes a bankrupt.

It is evident that if he were to content himself with more careful cultivation of a smaller area at the beginning of his settlement that he could secure a supply of water by local storage, wells, or ponds, sufficient to make certain in any year the crops necessary for the support of himself, family, and stock. The grasses on the high plains would enable him to feed cattle, and his 20 or 30 acres, intensively cultivated, would give a good supply of winter feed. By a reasonable diversity of crops the farmer on the great plains would, even under present conditions, soon find himself in possession of a home without debt and a certain means of sustenance. Local storage and a well supply, either or both, can be secured in almost every portion of the plains region. It is by such means that the transition period, from the present insecurity to a permanent system of water storage and distribution, will be most surely sustained.

IN CONCLUSION

Your committee submits the following tabulated estimate of the areas under cultivation by irrigation, and the total "under ditch." This table is presented as approximate, but it is believed to be within the facts:

Total area under ditch and irrigated.

States and Territories.	Under ditch.	Cultivated by irrigation.
	<i>Acres.</i>	<i>Acres.</i>
Arizona.....	455,000	225,000
California.....	4,000,000	3,300,000
Colorado.....	3,000,000	1,600,000
Idaho.....	715,000	500,000
Kansas.....	300,000	75,000
Montana.....	985,000	350,000
Nebraska.....	50,000	5,000
Nevada.....	142,000	70,000
New Mexico.....	800,000	625,000
Oregon.....	191,000	150,000
South Dakota.....	100,000	15,000
Texas.....	200,000	125,000
Utah.....	700,000	413,000
Washington.....	75,000	50,000
Wyoming.....	1,947,000	75,000
Total.....	13,661,000	7,578,000

In the western part of the State of South Dakota, in the region near the Black Hills, there are quite large areas under irrigation from ditches and canals taking water out of the streams in that country, which lands amount to many thousand acres. The system of irrigation there is being yearly enlarged. A canal now in process of construction, your committee is informed, will carry water for distribution for such purpose over some 40 miles in length. Many of the farmers who located in the western portion of South Dakota in an early day were from those parts of the country where irrigation was successfully practiced, and therefore knew the benefits of such practice, and upon settling on the lands at once made preparation for irrigation, took out the water from the streams, and proceeded to use it as needed. These early examples were observed by those settlers coming later, and thus large tracts of the very rich lands of that region are free from any danger of failure of crops by reason of drought.

The projects under way during the past year and partially completed will bring the acreage "under ditch" to at least 15,000,000 acres. Had last year not been one of severe drought, and the closing one of several during which the water supply was insufficient, there would have been an irrigated area under cultivation of at least 9,000,000 acres. British India supports over 150,000,000 persons on less than 26,000,000 acres of irrigated land. Not one irrigated acre in the arid region was before irrigation worth over \$5; 97 per cent. of it would not have brought the pre-emption price of public land, \$1.25 per acre. Its average value per acre is not less than \$30, or a total of \$302,520,000 for the area cultivated by irrigation in 1889.

Putting the entire area "under ditch" at \$25 per acre and we have a total value of \$389,125,000. Allowing for the final reclaimability of 100,000,000 acres out of the 1,200,000,000 acres embraced within the area of whole or partial aridity, and allowing \$20 per acre for its value when brought under ditch, we shall have as the result a real estate valuation of \$2,500,000,000. It will, indeed, be much more. Seventenths of the whole area is still the property of the United States. This public domain is a trust for the whole people; those of the future as well as those of to-day. The people are moving westward; nothing stays that movement.

By far the larger part of our current land entries are now made well within the line of partial and complete aridity. Is it not due then to

the people, our fellow-citizens, that we shall do all that can be done properly to lessen the hardship of their pioneer life and to enable them to make the most prosperous use of the opportunities that are before them? Should we not do the best possible to make available the unoccupied areas we still possess? Has any portion of our public domain, from the beginning of the history thereof, given any larger returns in manhood or in wealth wrung by severe toil from nature's most forbidding conditions, than that which has been wrought out and obtained in the regions west of the ninety-seventh degree of longitude? Your committee asserts that there is only one possible answer to these questions.

The passage then of the measures proposed by your committee will be wise in policy, just in action, and statesmanlike in results. In any event your committee insist that the legislation that may be adopted shall not present any dubious phraseology, so that under innocent words the arid West shall be deprived of two-thirds of the benefits that might be derived from a proper irrigation survey.

Congress certainly never intended to increase the appropriation for topographical surveying within the humid areas, nor facilitate the indirect growth of "research for science," by allowing the use of irrigation-survey appropriations in the making of topographical maps for the use of the Geological Survey. Both of these things have resulted from the past management of the Irrigation Survey, and, whatever other action may be taken, your committee believes that the facts it has presented will be a final bar to such singular interpretation of law and executive duty.

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VIEWS OF THE MINORITY.

The undersigned members of the Select Committee on Irrigation and Reclamation of Arid Lands, having considered the matters referred to it by the Senate, and having made as exhaustive an examination of the general questions relating to irrigation in the arid lands as time would permit, have reached conclusions which they desire to submit to the Senate. While the report of the majority of the committee contains much valuable information, we find ourselves unable to agree with many of its statements and with some of its reasoning, and we think many important facts are overlooked. We also disagree with its chief conclusions, and recommend Congressional action which is opposed to that recommended by the majority.

The following report is arranged in sections, each one of which treats of a distinct topic. In them the principal facts relating to the subject under investigation by the committee are arranged in order, so as to lead naturally to the conclusions that are ultimately reached. Then follow, numbered in sections, the recommendations which it is desired to make. And, finally, still in numbered sections, the bills and the report submitted by the other members of the committee are examined in detail and the reasons set forth for dissenting from the recommendations and views therein expressed. An abstract of all the sections is here given, numbered to correspond with the sections themselves.

ABSTRACT OF THIS REPORT.

I. The arid lands embrace an area of 1,340,000 square miles or 853,600,000 acres. Of this amount 100,000,000 acres can be redeemed for agriculture through the agency of irrigation by using the total supply of the perennial streams.

II. The water supply of the arid lands is to be derived from the streams, which are the chief source; from the storage of storm waters, which is the second source in importance; from pump-wells, which are the third source in importance; and from artesian wells, which have some value for horticultural and stock-raising purposes.

III. The subhumid region lies between the arid region of the west and the humid region of the east, and embraces an area of about three degrees in width, equal to 250,000 square miles. Disaster has generally come to farmers who have attempted to settle in this region and carry on agriculture without irrigation.

IV. When the system of applying the water is good and the cultivation is thorough, waters used in irrigation are consumed.

V. It would be greatly to the advantage of the farmers on the irrigable lands if a proper system of measuring the waters with which they are supplied were adopted, and great waste would be avoided.

VI. Experience proves that the arid and subhumid lands are very fertile when irrigated.

VII. The forest lands are of limited extent and are being rapidly burned and need protection. These forests are distant from the irrigable lands, where the agricultural population must be established in homes, but the farmers are dependent upon them for their supply of wood and lumber. They are also dependent upon them for their full supply of water for irrigation. Therefore, in the interest of the farmers, the forests should be protected.

VIII. There are great areas of pasturage lands which furnish a scant but valuable supply of food for flocks and herds, and the farmers engaged in irrigation can utilize this pasturage to the best advantage. But it also is being destroyed and needs protection, and the farmers with permanent homes are the people primarily interested in its protection.

IX. The lands that can be irrigated are narrowly limited in area, so that only a small portion can be redeemed when all the waters are used. The best lands lie at the foot of the mountains and near to them, and should be chosen for this purpose. The mountain lands are not good agricultural lands, and the lands far down the streams can be used only by a great waste of waters. The irrigable lands should be carefully selected.

X. The irrigable lands should be segregated and declared such, and the right to use water on them should be established and a prohibition should be put to the use of water on all other lands.

XI. Irrigated lands are of great value, varying from \$25 to \$200 per acre.

XII. The size of the homestead should be reduced to 80 acres, and perhaps 40 would be better, that the public domain may be distributed among the greatest number of people.

XIII. Water rights are often established that impede the development of agriculture and are greatly obstructive.

XIV. International conflicts in relation to water rights are impending.

XV. Conflicting rights to the use of waters in different States are being established and bitter conflicts have already begun. These rights are of great magnitude, involving hundreds of millions of dollars. The general problem, therefore, is a national problem.

XVI. Many conflicts are arising between communities in relation to the use of water on the land, and between individuals in the same community. The waters should be divided by some just method.

XVII. Speculative water rights, where work of value has not actually been done and lands irrigated, should be summarily extinguished.

XVIII. Existing water rights should be maintained, but those that are improvident and obstructive must ultimately be condemned and the owners justly remunerated.

XIX. Waters that are to be stored have to be divided among the communities.

XX. In many regions the people are developing agriculture where it can not be permanently maintained, and the foundations for large claims against the General Government are being laid.

XXI. Both the waters and the lands of the arid region are rapidly being aggregated in the hands of a few persons or in the possession of great corporations. Thus a result is being secured unfavorable to the welfare of the great body of people who perform the labor on the farms—the actual farmers themselves.

XXII. The Government need not construct irrigating works. The increase given to the value of the land is more than sufficient to cover the expense of such construction.

XXIII. It is possible to divide the arid region dependent upon perennial stream waters into irrigation districts, so that each one may have a catchment area and a corresponding irrigable area where the waters of the district can be used to the best advantage and where water rights can be permanently maintained. Such districts have been provisionally planned and mapped by the Director of the Geological Survey.

XXIV. Irrigation districts should be composed of compact bodies of irrigable lands, with the pasturage and timber lands of the catchment area about them, and the farmers on the irrigable lands should control the catchment areas with all their values.

XXV. Interstate complications make it necessary for the General Government to provide a solution of the problems; and the United States and the several States are interested in the waters and lands; hence, the United States and the several States must alike make concessions and reach an agreement.

XXVI. The population in each of the irrigation districts planned seems usually to be sufficient to take charge of the interests involved in such districts in relation to the use of waters, forests, and pasturage. The district with the smallest population is that of Bill Williams' Fork in Arizona. The district with the largest population is that of the Upper South Platte, which includes the city of Denver, and probably has a population of more than 142,000 people.

XXVII. The solution of the foregoing problems is very simple. It consists in organizing natural irrigation districts through the agency of a survey by the General Government and necessary legislation by the States, and in turning over the practical work of irrigation to such districts.

XXVIII. The present Irrigation Survey is performing its duties in compliance with law and in an efficient and thorough manner, and the work under it should proceed at a reasonable rate of progress until it is finished. It is estimated that the irrigation survey will cost \$7,000,000, but that in making the maps it will save \$4,000,000 to the Geological Survey. Thus the real cost of the irrigation survey is but \$3,000,000 over and above the cost of the Geological Survey. The work performed in two years demonstrates that this estimate is reasonable and justifies the further estimate that with the annual appropriation of \$1,000,000 the irrigation survey of the entire country could be completed in seven years.

XXIX. The survey needed for the subhumid region of the Great Plains is purely a geological survey based on topography. It should be made as rapidly as possible, in order to serve the wants of the farmers of that region, who are already suffering by reason of their neglect of irrigation. Another reason for its prompt completion is to give to new settlers in these regions necessary information of the conditions under which success and prosperity may be secured.

XXX. To accomplish the solution of the problems by the method proposed, a bill has been draughted, which is appended to this report.

XXXI. An analysis of the bill is made by sections, and the effect of each section pointed out. The sections may here be characterized summarily. Section 1 of the bill provides for a survey of the arid lands into natural irrigation districts. Section 2 provides for the segregation of the irrigable lands. Section 3 provides that lands already irrigated shall be declared irrigable for the purposes contemplated in

the bill. Section 4 provides that certain of the irrigation works shall be constructed only on sites designated and reserved therefor, in order to protect water rights and to conserve the waters for beneficial purposes. Section 5 provides for the division of the waters among the districts. Section 6 provides for the organization of districts situated in two or more States or Territories. Section 7 provides that the non-irrigable lands shall remain in the possession of the General Government, as forests and pasturage reservations and catchment areas for the irrigable lands, and also provides for the disposal of the irrigable lands to homestead settlers in tracts not greater than 80 acres. Section 8 attaches the water rights to the homesteads of the irrigable lands. Section 9 makes it unlawful to construct unauthorized irrigation works. Section 10 provides in general terms a plan for the organization of irrigation districts. Section 11 gives to the commissioners of the irrigation districts the authority to provide laws and rules for the use of the waters belonging to the districts and for the protection and use of the forests and the protection and use of the pasturage. Section 12 makes it lawful for the States and Territories to provide general legislation relating to the use of the waters, the forests, and the pasturage, and provides methods by which the capital for the construction of irrigation works may be obtained. Section 13 makes it lawful for the States to provide boards of irrigation commissioners to supervise and approve of the works authorized and the contracts made by district commissioners. Section 14 provides that cities and towns may be excluded from the irrigation districts, and gives the States and Territories authority to designate the waters which such cities and towns may use. Section 15 provides a method for obtaining the consent of the States and Territories to the legislation proposed in the bill, and refuses the rights and benefits otherwise granted to any State or Territory which fails to give its consent.

XXXII. The general effect of the bill is to turn over the control of irrigation to the States and the districts, the general statutes to be made by the States and the specific rules by the districts. Therefore it will accomplish local self-government in relation to irrigation and the forest and pasturage administration. It relieves the General Government of all subsequent legislative and administrative duties, except only to complete the irrigation survey of the whole and the linear survey of the irrigable lands, and also to administer the homestead laws, coal-land laws, mining-land laws, and townsite-land laws through the General Land Office.

XXXIII. The bill reported by the majority of the committee is in the interest of the great cattle companies that pasture their animals on the public domain, and opposed to the interests of the farmers making homesteads on the lands. Its effect is to give the companies access with their animals to "all natural waters, whether the same be running streams, lakes, pools, ponds, springs, or other surface bodies of water, or subterranean streams, pools, or underflows produced by natural seepage or drainage," in disregard of the authority of the States. It is also in the interest of the great irrigation companies rapidly developing in the West, turning over all water rights for irrigation to them and practically excluding the poor settler wishing to obtain a homestead on the land. Therefore it is disapproved.

XXXIV. The creation of a new bureau of irrigation in the Agricultural Department is unnecessary and unwise; therefore it is not recommended.

XXXV. The Director of the Survey has expended a portion of the



funds for necessary topographic work as a part of the irrigation survey. This is strictly in compliance with the statute. It is also in compliance with the plan for the survey submitted to Congress by the Director prior to the enactment of the law. It is strictly in compliance with the representations made by the Director to the Committee on Appropriations and published by that committee in its report to the Senate explaining the bill. Three months after the passage of the bill the Director reported to Congress how this work had been organized and was being prosecuted, showing that it was strictly in compliance with the law and that topographic work had been begun. The topographic work is necessary, economical, and legal.

XXXVI. The recommendation to discontinue the topographic work of the irrigation survey is considered unwise. It is believed that through this method catchment areas, sites for diverting works, canal sites, reservoir sites, and irrigable lands can be discovered with the greatest economy and thoroughness. It is also believed to be the proper basis for a hydrographic survey.

XXXVII. The hydrographic branch of the irrigation survey should not be turned over to the Signal Service. The stations of the Signal Service in the arid lands are not at the places where the streams should be gauged. A new corps of men would be necessary, and it is believed that the measuring of the waters to be used for irrigation can be most economically and promptly done by the irrigation survey through the topographic work.

XXXVIII. The two bills are diametrically opposed in theory, purpose, and effect. The bill recommended by the minority is in the interests of the farmers themselves; the one by the majority in the interest of companies. The one proposes to continue the present irrigation survey, while the other proposes to create a new bureau of irrigation and a second geological survey.

XXXIX. Director Powell does not suggest that irrigation works should be constructed by the General Government, but he has consistently for a long term of years urged that the industry of agriculture by irrigation should be under the control of natural irrigation districts.

XL. No delay in the operations of the irrigation survey is caused by the operations of the geological survey, but wherever maps are made in the arid and subhumid regions for the geological survey they serve the purposes of the irrigation survey, and forward its work.

XLI. The legislation already accomplished by the act of October 2, 1888, which reserves the sites for irrigating works in the hands of the General Government and reserves the lands made susceptible of irrigation thereby for homestead settlement is wise and should not be repealed. The desert-land laws, the timber-culture laws, and the pre-emption laws, which are in effect repealed by that act, should not again be made operative, for by their agency large tracts of land have heretofore been aggregated in the hands of wealthy individuals and corporations.

XLII. Experimental boring without a geological survey for the discovery of artesian waters is unwise. The experience of the world demonstrates that the supply of artesian waters is always of insignificant amount and inadequate to the wants of agriculture, though such fountains are valuable for domestic and horticultural purposes. Especially is it unwise to create a new geological survey to discover artesian waters

THE REPORT.

SECTION I.

THE ARID LANDS.

To the west of the ninety-third meridian, treeless plains stretching from the northern to the southern boundary extend westward to the Rocky Mountains. Across these plains the climate becomes more and more arid until the one hundredth meridian is reached, beyond which the climate is so dry that agriculture is dependent upon an artificial supply of water, the rains being insufficient to fertilize crops. This condition of aridity extends beyond the Rocky Mountains across the Great Basin and below San Francisco to the Pacific, but north of San Francisco there is a humid area which expands until the British line is reached.

This arid region embraces an area of about 1,340,000 square miles. The greater part of the region is composed of plains, table-lands, treeless valleys, and lofty mountains. The rain-fall is chiefly concentrated on the mountains; and thence flow many rivers. The most noteworthy of these are the Missouri, the Yellowstone, the Platte, the Arkansas, the Rio Grande, the Colorado, the San Joaquin, the Sacramento, the Shoshone and the Columbia. The mountains are not valuable for agricultural purposes, as they are rugged and inhospitable because of their great altitude. On them deep snows fall, and the summer seasons are cold and frosty. Though the plains, the table-lands, and the valleys are treeless, and bear scant vegetation, yet they are covered with rich soils. But agriculture dependent upon rain-fall is not possible. The lands can be redeemed for agricultural industries only by being supplied artificially with water; they must be irrigated. This condition is not unknown elsewhere in the world. Agriculture by means of irrigation has been practiced from the dawn of civilization to the present time in many lands. In fact much of the agriculture of the world is carried on under these conditions. The problems involved in irrigation are therefore old, and man has had great experience in bringing arid lands under the dominion of farming industries.

SECTION II.

THE WATER SUPPLY OF THE ARID LANDS.

In considering how these lands are to become available as homesteads for an ever and rapidly increasing population it becomes necessary to consider the supply of water which can be used in irrigation. There are four sources from which this supply may be drawn, namely, stream waters, storm waters, well waters, and artesian waters. The chief supply of water for irrigation must come from the utilization of the peren-

nial streams—the springs, brooks, creeks, and rivers. The source of these streams is in the mountains, where there is a great concentration of rain-fall. It is computed by Director Powell, of the Geological Survey, who has studied this subject with care for many years, that 100,000,000 acres of land can ultimately be irrigated by the use of these stream waters; but this requires that the entire supply shall be utilized. Growing crops need irrigation for but a few months of the year, and if the streams are used only during such months and are permitted to run freely to the sea or to be lost in the desert sands during the remaining portion of the year, much less than one-half of this amount can be cultivated. To obtain the complete service of all of the streams for the fertilization of the lands it becomes necessary to store the surplus waters in reservoirs or artificial lakes. When the surplus waters are stored in this manner, so that the entire volume of all the streams during the year is controlled and spread over the soil, then, and not till then, can the 100,000,000 acres be brought under cultivation.

The storm waters constitute the second source of supply. The mountain storm waters feed the streams, and they can not be used both as storm waters and stream waters; they are therefore included in the stream waters. But on the plains, valleys, and table-lands, where the rain-fall is less and the lands are comparatively flat, the storm waters feed perennial streams only to a very small degree. A part of these waters are caught in the sand of the general surface and evaporated; another part flows down into the sand-blocked valleys, where it slowly evaporates. These waters, that flow only after storms and are called storm waters, can be caught and held in reservoirs or tanks and spread upon the lands for irrigation. Many great districts in the arid lands of the world are irrigated in this manner.

Still other rain waters penetrate the rocks and sands below, from which they can be recovered by sinking wells and bringing them over the lands through the agency of pumps. The lands irrigated in this manner throughout the world are, in the aggregate, of considerable importance, but the several tracts thus irrigated are small. In one district in Asia there are 400,000 such wells, and from them 1,125,000 acres of land are irrigated.

There is still a fourth source of water to be mentioned. In some districts of the world the geologic structure is such that the rock strata form underground basins. On the margin of these basins the edges of the rock that are turned up catch the rain waters, and they slowly percolate down through the rocks. Into these basins wells may be bored, and fountains will spring up and overflow. Such artesian waters are sometimes used for irrigation in supplying gardens, orchards, and vineyards, but nowhere in the world is agriculture in the proper sense carried on by means of artesian fountains. The areas where such waters can be found are limited in extent, and the amount of water which an average well will afford is small, and the number of wells which any district will permanently maintain is comparatively small.

Such are the sources of water supply for the arid lands. How much of the great area which has been described can be brought under cultivation by the use of storm waters, pump waters, and artesian waters is not known. No trustworthy data have been collected concerning these upon which estimates can be based. Still it is believed by Director Powell, who has studied the subject, that considerable areas will ultimately be redeemed in this manner, chiefly by the use of storm waters, in addition to the hundred million acres reclaimable by stream waters.

Director Powell has placed before the committee a map of the arid region, on which are delineated the lands which have been irrigated. This map appears with the report of the committee in connection with his statement. He has also furnished a table showing by States and Territories the amount of land cultivated in each. From this it appears that about 8,000,000 acres of land have been irrigated, and these lands are distributed through all the States and Territories of the arid region. Irrigation has, therefore, been practised in the United States to such an extent that it is no longer an experiment, and the history of the development of agriculture in this manner reveals many interesting and important facts which are of profound interest to the statesman who regards with solicitude the welfare of the people.

SECTION III.

THE SUBHUMID REGION.

East of the one hundredth meridian there is a belt of country two or three degrees in width where the supply of rain sufficient for agriculture is precarious. In some years the rain-fall is ample; in other years it is entirely insufficient, and in such seasons the farmer reaps no reward for his toil. The history of farming for the past two decades in this subhumid region is full of instructive lessons. Experience shows that wet and dry years alternate in groups. Two or more wet seasons will be followed by two or more dry seasons. When a period of sufficient rain-fall comes for several years in succession, settlers enter upon the subhumid lands in great numbers, tempted by the fertility of the soil and the salubrity of the climate, and their first years are marked by prosperity, especially in those regions where great wheat fields can be cultivated at small expense; but when a succession of dry years appear, and one crop after another fails, the wealth of the people melts away. For the means of subsistence the people mortgage their lands. Horses, cattle, and sheep must be dispensed with, because they devour the subsistence which wives and children need, until at last hunger drives the people away. In the meantime the money-lenders and speculators foreclose their mortgages and get possession of the lands, and when seasons of rain-fall come, another period of land speculation is developed, and the lands are cultivated as farms by people who in their turn must be ruined and driven from the country. Such years of disaster have come two or three times to some portions of the subhumid region. Kansas has been the scene of suffering three times, and in North Dakota and South Dakota the people are now passing through such a period. The disaster that arises from these years of poverty is greatly aggravated by the land speculators, who, with wealth at their command, are enabled during years of plenty to create a belief among the people that the climate is permanently changed, and, fixed in this opinion, the settlers fail to provide against the years of want.

Perhaps, in the history of the United States, there has never been so large a body of people so hopelessly ruined by false representation and speculative chicanery as the people who have settled from time to time in this subhumid region. To the statesman it is a question of the most profound importance whether any relief can be afforded to the people under this condition of affairs, and whether the subhumid region can ever sustain a large agricultural population. To the solution of this question the Director of the Survey appears to have devoted his energies, and he states that there are similar lands

throughout the world supporting prosperous people in great numbers, people who resort to irrigation and thereby cultivate gardens, orchards, vineyards, and small farms. In such regions as our own subhumid belt, small streams are few, though rivers flow across them, which head in high mountains far away; and irrigation is, in the main, rendered possible by the storage of storm waters, though, to some extent, as in India, pump waters are used, and to a slight extent, artesian waters. The people who inhabit such lands do not engage in agriculture on a large scale; but in addition to their gardens and small farms, they raise flocks and herds. Unfortunately, in the United States this subhumid region has usually been the theater of farming operations on a large scale. The lands being treeless, they can be brought under the plow with little expense, and when the rain-fall is sufficient it is but necessary to plow and sow, and the farmer may reap in abundance. But such prosperity is always the forerunner of adversity.

SECTION IV.

WATERS USED IN IRRIGATION ARE CONSUMED.

When waters are taken from streams to be used for powers they can be returned, and are thus not lost but only utilized on their way to the sea. In the same manner, waters used for manufacturing and mining purposes can be returned to the channels; though they are sometime injured by being polluted, they are not lost. In contrast with this the waters used for irrigation are consumed; they are poured upon the land and are evaporated from the surface of the soil, but chiefly from the growing plants; they are thus taken up and discharged again into the atmosphere. As irrigation is practiced in most places in the United States, not all of the waters are thus returned directly to the air. By imperfect control of the canals and minor water-ways notable bodies of water escape to be returned to the natural channels. Other bodies of water escape by seepage or percolation through channels constructed in sands and other pervious materials. As irrigation is now practiced there is usually an excess of water put upon the land, more than will be evaporated by the plants and from the surface of the soil. This also escapes into the natural channels. All such escaping waters can be used again to a greater or less extent below. The amount of this waste water gradually diminishes with the development of more thorough methods of irrigation and cultivation of the soil, until at last, as in some places in southern California, such a high degree of excellence is reached in the processes of irrigation and cultivation that no waters escape in this manner. The waste water of irrigation is a measure of the degree of imperfection in the system of irrigation and cultivation. It should be the endeavor of the farmer to prevent waste by evaporation and by faulty methods of irrigation, for in this manner less water is needed, and the amount paid for the delivery of water will be less, while on the other hand the area actually redeemed by irrigation will thus be increased. In the estimate which the Director of the Survey makes, that 100,000,000 acres of land in the arid region can be redeemed by the use of all the streams, this fact is taken into consideration and it is assumed that ultimately the methods of irrigation and cultivation will be perfected as they are in regions of country like the eastern portion of Spain, where irrigation has been long practiced.

SECTION V.

THE CUSTOMARY METHOD OF MEASURING THE WATER SUPPLIED TO LANDS LEADS TO GREAT WASTE AND SERIOUS LITIGATION.

The settlers on the arid lands engaged in these new farming industries without experience, and they were usually not informed of the amount of water necessary to irrigate an acre of land for a season. They have therefore entered into contracts with the water companies to furnish the necessary water for definite quantities of land, whatever that might be. This condition of affairs leads to serious difficulties. The farmer has a contract right to the water necessary for the land he is cultivating. But such water may be used economically or wastefully. An economic use may be one half, one-fourth, or one-tenth of a wasteful use. Such wasteful use arises in two ways. The chief source of evaporation from the surface of cultivated land is from the growing plants. If the cultivated plants only are allowed to grow, and the weeds exterminated, the rate of evaporation is comparatively small; but if the farm is badly cultivated, the waste by evaporation is very great. The careful farmer uses but little water, the careless farmer very much. Again, the economic use of the water depends very largely upon the construction and maintenance of the minor canals, or furrows, which ramify over the land, or other works used to distribute the water. If these works are badly constructed or not carefully managed, the water bursts away and runs to waste. The waste from these sources can be avoided by the good management of the farmer; but he is not interested in its prevention. The party directly interested therein is the one under contract to supply the water, and it is not within his power to exercise economy. Thus it is that large quantities of water are wasted. When the fields are irrigated streams burst out from their borders and the water is lost, or the lands are badly cultivated and the waters are evaporated without doing duty to the growing crop. The ultimate result of this is that the farmers as a body have to pay for this waste water, and the careful farmers have to assist in paying for the waste of their neighbors. When waters thus run to waste, sometimes the companies and sometimes interested neighbors are compelled to interfere, and this causes conflict, embroils communities, and results in litigation. Contracts for the delivery of water should be made in terms of quantity supplied, and not in terms of quantity of land to which it is supplied; then the responsibility for economy will rest upon those who only can practice economy, and much conflict and litigation will be avoided.

SECTION VI.

ARID LANDS ARE FERTILE.

During the last summer the committee made a long journey, in passing through all the States and Territories where irrigation is practiced, and it appears from the statements made by the people, and from the examples which the members of the committee observed for themselves, that lands under irrigation are very fertile, and that although much labor and expense are attendant on such farming the farmer is well rewarded therefor. It is believed that the truth of this statement is abundantly demonstrated after all due allowance is made for exaggeration. It therefore pays to irrigate desert lands wherever water can be brought upon

them at a reasonable expense. It was not uncommon to find desert lands separated from irrigated lands only by fence lines, the desert lands being valueless or nearly so, while the irrigated lands were valued and actually sold at rates varying from \$25 to \$200 per acre, depending upon their proximity to centers of population. It was further to be noticed that irrigated lands are usually cultivated to a high degree, for after the expense of bringing water upon them has been incurred, thorough cultivation is demanded that the investment may not be lost.

SECTION VII.

THE TIMBER LANDS.

The Director of the Survey also placed before the committee a map of the arid lands exhibiting the distribution of forests. In his statement, which is published with the report, a table is given of the number of square miles of forest valuable for merchantable timber in the several States and Territories of the arid lands. Such forests are found only on the mountains and very high plateaus, and they are chiefly composed of coniferous trees, as pines, spruces, and firs, which are exceedingly inflammable. It appears from the evidence coming from various sources that these forests are being rapidly destroyed by fire. The destruction of values in this manner is enormous, and unless something can be done to prevent it, the ultimate destruction of all the standing timber will come in a few years. These forests are mainly found in lands where agriculture is almost impossible, as the region where trees grow is cold and inhospitable. The forest lands are mountainous lands, while the agricultural lands lie below on the plains. It is thus that the farmer is usually dependent on a distant region for his fire-wood and for the timber which he uses in building his home and which he needs for a variety of purposes.

There is still another class of timber lands, the forests of which are scant and composed of low, scrubby trees valuable only for fire-wood and minor domestic purposes. Some of these forests are found where agriculture is possible.

The most important fact in connection with these timber lands arises from their relation to agriculture. The agricultural lands are below, in the valleys; the chief sources of water supply are in the mountains, where the forests grow, and these sources can be greatly injured through the destruction of the forests. To a large extent the waters that are to be stored must be held in reservoirs in the mountain regions, and if the hills are improperly denuded of their trees, the reservoirs will speedily become filled with débris. To serve the full water supply for the lands below the forest lands must be protected. It is thus that the farmers who live far away in the valleys are the people directly interested in the management and protection of the forests, for the double purpose of preserving their agricultural interests and for the supply of wood and lumber to be obtained therefrom. It is not possible to overurge upon Congress the importance of this question. Vast values are being destroyed by fire annually and the farming interests are being imperiled thereby.

SECTION VIII.

PASTURAGE LANDS.

Besides the forest lands and irrigable lands, there are large tracts valuable only for pasturage purposes. The grasses on these lands are in the main very scant, though nutritious, and on them many herds and flocks are sustained. A few decades ago, throughout the arid region,

ranching industries sprang up on the public domain, and large tracts of land were claimed by individuals and corporations engaged in stock-raising. To such large tracts possessory titles were claimed, and they were sometimes inclosed in fences tens, or hundreds, of miles in length. At first this ranching commenced in a small way, but gradually the larger companies absorbed the smaller, buying out individual properties, or driving the owners away, until at last the strong arm of the Government was invoked, and in many cases the companies have been compelled to remove their fences and throw open the public domain to the use of all. Still, many of these ranches have a firmer hold on the country, which they have gained through the purchase of Spanish grants and tracts of railroad lands. Others have obtained title and possession of lands through the agency of the homestead laws, pre-emption laws, timber-culture laws, and desert-land laws, and by purchase of lands granted to the States by the General Government. Often these lands have been acquired by companies through the agency of their employes, who take up tracts under the various acts of Congress for the purpose of acquiring title thereto and transferring the same to their employers. Some of the irrigable lands have been aggregated in large holdings in the same manner.

Rapidly the existing cattle companies are being consolidated and organized into trusts with beef companies in the cities farther to the east. Thus great syndicates are formed having their ramifications throughout the entire country so as to control the raising of cattle, the marketing and butchering of the same, and the distribution of the meat to the people. In the mean time the development of agriculture by irrigation is giving support to many smaller farmers who cultivate tracts of lands for themselves and raise flocks and herds to compete with the great companies. These farmers in vast numbers complain bitterly of the power which the great syndicates have in controlling lines of transportation and markets; but their chief complaint against the companies arises from the fact that the syndicates are able to cover the lands with their herds and occupy the public domain to the exclusion of the few animals held by the smaller farmers who can not afford to employ herders to guard and protect the small number of animals which they own. Thus they are compelled to keep them in their own fields or lose them in the great herds. In this connection it should be explained that the natural pasturage lands can not be economically used and fenced in small tracts, as many acres are required to support a single animal.

Notwithstanding all these facts the farming interests are gradually encroaching on the ranching interests. The value of the farming interests is already greatly in excess of that of the ranching interests, and the people engaged in farming are likewise vastly more numerous than those engaged in ranching; and this disparity must rapidly increase in the future. In fact, the time is approaching when the ranching interests will be largely absorbed in the farming interests; and this is already accomplished in many districts. The ranchmen are beginning to farm by means of irrigation, and the farmers are increasing their flock and herds. It is believed that it would be highly advantageous if these interests could be wholly consolidated, so that the people who are engaged in farming could have control of the pasturage lands and utilize them to the extent of their value.

There is another consideration of great importance relating to the pasturage lands. This exists in the fact that if they are overstocked they are destroyed. Some of these impoverished grass lands ultimately recover; others do not. Already extensive districts have been laid waste

in this manner, and it is believed that the permanent settlers who have agricultural homes will be the people most interested in the protection and utilization of the pasturage lands; and if this condition were secured the cattle-raising industry would become an adjunct to the farming industry which is carried on by irrigation. If a proper system could be devised the ranchmen who are permanently located would gradually become farmers, while those who roam from region to region with their flock and herds, and who thus destroy the pasturage lands, would have to abandon their nomadic industries and seek fixed habitations, and would thus become permanent inhabitants with interests in common with all the farmers.

SECTION IX.

THE IRRIGABLE LANDS LIMITED.

The irrigable lands are limited in extent. The area of the arid region which can be irrigated is a small fraction of the entire region. This arises from the fact that all the waters that can be used are insufficient to serve all the possible irrigable lands. It therefore becomes necessary to select the lands to be redeemed. On the wisdom of this selection vast interests depend. It is possible to irrigate lands in the mountains and on the high plateaus, but if the water is used there it can not be used below, and these elevated lands will not make the best homes for the people. The climate there is rigorous; and the variety of agricultural products that can be raised is limited, being chiefly hay and vegetables. To use the water on such lands is largely to waste it, and to drive agriculture into the mountains is to doom the people engaged therein to a dreary life in a subarctic climate. It is therefore manifestly to the interest of the greatest number of people that the agriculture of the arid lands should not be established in the mountain regions. The valleys and plains below are warm, salubrious, and rich, the variety of agricultural products is great, and if the waters are used on these lands they will give support to a prosperous people.

But not all of the valley and plain lands can be irrigated, and selections from these must be made, and on the wisdom of these selections much depends. If the lands are selected far down the valleys, the waters are wasted in reaching them. It is generally the case that after leaving the foot-hills of the mountains, the creeks and rivers of the Western lands are rapidly absorbed in the sands, and thence evaporated; in fact, a great many of the streams disappear altogether within a few miles after leaving the foot-hills, being lost in sinks or salt lakes. It is thus estimated that more than half of the streams that flow from the mountains do not ultimately discharge their waters into the sea, while of the water of the streams that do ultimately flow through to the ocean a very large part is lost on the way where it is caught by the sands. If the lands are selected far away from the mountains and the waters are taken out near to the mountains, then long lines of canals must be constructed, involving great expense. And experience shows that it is not practicable to conduct water along canals dug in the soils and sands of the plains and valleys to a great distance, for into the sands on either side the waters percolate and are steadily lost to agriculture on their way to the distant tracts. In order that the greatest area may be irrigated, therefore, it is necessary to select the irrigable lands on the highest good land that can be found to which the waters can be taken. The agriculture of the arid regions should be aggregated on compact bodies of land below the mountains, in the valleys and on the

plains, where the climate is genial and the waters will not be wasted. The agricultural people will thus be collected in comparatively dense communities separated by wide spaces of pasturage and timber lands, which they can utilize to great advantage.

A difference of 100 or 200 miles along the course of a stream may make a difference in the amount of land that can be irrigated of five, ten, or twenty fold; that is, the waters will irrigate that much more land if it is selected above. It thus appears that a proper selection of the irrigable lands must be made so as to exclude tracts in the mountains and on the high plateaus, and also far down the valleys where the waters would be wasted in reaching them. The ultimate area which is to be redeemed through the agency of streams depends very largely on a wise provision in the selection of the lands to be irrigated. If the lands are badly selected, and rights and interests are vested to the use of waters on lands improvidently chosen, the development of agriculture will be limited. In the interest of the future agriculture of the arid lands the most important function which the General Government can perform is promptly to select the irrigable lands and direct the attention of settlers thereto, and permit them to make homesteads thereon, thereby preventing the establishment of improvident rights. The people settling in the country can not do it for themselves in a proper manner, as they are necessarily ignorant of the facts and conditions; they therefore settle at random on tracts scattered promiscuously throughout the regions where irrigation is possible. Some tracts are well selected; others are badly selected.

SECTION X.

THE IMPORTANCE OF DEFINING THE IRRIGABLE LANDS.

It is a matter of prime importance that the irrigable lands shall be selected and defined and water rights established to such lands in advance of settlement, so far as that is yet possible, in order that the agricultural industries growing up in the arid lands may be permanent. It has already been shown that the amount of land which can be irrigated depends upon wise selection; if the selection is made at random, or improperly, the area which it may be possible to irrigate may be reduced to one-half, one-quarter, or even one-tenth of the normal amount; hence, for the welfare of the greatest number of people, these lands should now be selected and defined.

It is also important that the people settling on these lands shall be informed definitely of the catchment area of the waters relegated to their lands, in order that they may protect them from spoliation, and in order that they may not endeavor to acquire water rights which they can not ultimately maintain.

It is also important that the amount of each selected tract of irrigable lands shall be restricted to the amount which the water of each catchment area will serve. If this is not done, then the owners of the land, the farmers, become interested in the failure of their neighbors. For if another man's prosperity enables him to develop the irrigation of his farm to the fullest extent in a short time, and thus subtracts from my prospective rights and hope for prosperity, he becomes a dangerous rival; but if I know that he may develop all of his lands and that there will still be left a sufficient water supply for my lands when the time comes that I can use it all, his prosperity is no longer dangerous to me. In the same manner, if each agricultural community has a

body of water rights inhering in a catchment area attached to the defined irrigable lands of that area, sufficient and no more than sufficient for the irrigation of that area, the prosperity of that community is not a menace to another agricultural community having similar water rights pertaining to similarly defined irrigable lands.

The principle at the foundation of the plan herein proposed is exceedingly simple. It is that the arid lands depending for irrigation upon perennial streams shall be divided into irrigation districts so that each shall have a defined body of irrigable lands and a defined catchment area, and that the lands and waters shall thus be related, the lands being just sufficient, and no more, to use all the water which the catchment area will provide. If this is established, the district which develops rapidly can not destroy the district which develops slowly. One community can not become the rival and enemy of another — all community water rights will be clearly defined and can be maintained.

SECTION XI.

THE VALUE OF IRRIGABLE LANDS.

If the irrigable lands are wisely selected and are declared irrigable lands and the right to use the water on such lands is established, and a prohibition is put to the use of waters on other lands in such a manner that water rights inhere perpetually in the designated irrigable lands, such lands will be immediately given great value, varying from \$25 to \$200 per acre, depending upon their proximity to cities, towns, mining regions, and railroads.

SECTION XII.

SMALL FARMS BEST FOR THE ARID AND SUBHUMID REGIONS.

It is an established principle of agricultural economy that where land has high value cultivation must be thorough. With land of small cost it may be more profitable for a farmer to bestow a small amount of labor per acre upon a large farm than to bestow a larger amount of labor per acre on a small farm. But if the cost of land is great he must cultivate his land thoroughly, and if he employ only his own labor his farm must be small.

Irrigated land is expensive in two ways: First, outlay is necessary in the original construction of reservoirs, dams, canals, and other irrigation works, to reclaim the land; second, money must be expended annually in the maintenance of irrigation works, and much labor is required through the irrigation season in systematically leading the water to different parts of the land as it is required. For these reasons the cultivation of the soil must be thorough or the investment in irrigation will not be remunerative. In order to get the proper return for the money invested and the labor annually expended, the highest cultivation is demanded. So great is the labor of leading the water on the lands, and so great is the labor necessary to cultivate the soil to a high degree, that the area one man can profitably cultivate is much smaller than in a humid region. The labor necessary to cultivate 40 acres of land in a humid region is sufficient to cultivate only 10 or 15 acres in an arid region. Hence the homestead unit for the arid region should not be so much as 160 acres, but only 80 acres, or perhaps only 40 acres.

Such limitation of the area which may be secured by homestead will work no hardship to the farmer, for his smaller farm in the arid region is more productive than a larger farm in the humid region. As just explained, he is under the necessity of maintaining a high degree of cultivation, and this leads to correspondingly large production. But this is not all. Agriculture watered by means of irrigation is in two ways essentially superior to agriculture watered by rains. First, the supply of water, being under the control of the farmer, is better regulated, and the land does not suffer either from violent rains or from droughts; second, the dryness of the air in the arid region is favorable to the growth of crops, so that even in the years most favorable to agriculture in the humid region the irrigated lands of the arid region yield a more abundant return.

It was found by the committee, in passing through the Western States and Territories during the past summer, that the farmers who were practically engaged in agriculture fully recognize these facts, and the general sentiment expressed was that the homestead privilege should not include more than 40 acres of land; others believe 80 acres to be the right quantity, while nowhere among the farmers was it claimed that 160 acres should be given as a homestead. The universal sentiment of the farmers of the West, who are practically informed on these matters, is in favor of a much smaller homestead than is now given to the settler. The value of a tract of irrigable land with water right attached is always great. Everywhere in the arid region such tracts are valued at and sell for from \$25 to \$200 per acre; so that a tract of 80 or even 40 acres is no inconsiderable gift to the settler.

SECTION XIII.

OBSTRUCTIVE WATER RIGHTS.

For the proper utilization of the waters of the streams, there is another condition of importance. In inaugurating irrigation plans it is often the case that a stream is diverted by the construction of imperfect dams of brush, sand-bags, or loose stones sufficient to take out a portion of the water and turn it into a canal, but insufficient to take out the entire volume. Such diverting dams and the low-line canals which they feed are constructed along the course of the river. In order to supply them with water a much larger volume must run down the stream than is taken out into the low-line canals. To maintain rights thus established is to prevent the complete utilization of the waters. If the entire volume of the stream be taken out at some point above them all, where headworks can be constructed to fully command the stream, then the water is cut off from the low-line headworks and canals and is made to serve a much larger area at a smaller expense per acre; but vested rights in many cases prevent this economical use of the river. This difficulty is frequently experienced, and has already become of grave importance; and such impedimentary and improvident works have ultimately to be bought out. For this reason it becomes necessary to designate the points where waters can be taken out from the principal streams, in order that the water may be utilized on the best lands and to the greatest extent.

In the progress of irrigation, the small streams are generally utilized before the larger. In very many cases these small streams are used low down in their courses, on lands lying near to the trunk streams into which they flow; afterwards, when it is desired to take out the

waters of the trunk streams, it is found that the lands which their waters could serve are already served by waters from the small streams, and to use the larger rivers it becomes necessary to buy out the interests of the farmers on the small streams, who must then move back higher up the little tributaries with their farms. It is thus that in a second way obstructive and improvident rights are established. The experience gained by the irrigation of 8,000,000 acres of land shows that such obstructive and improvident rights have been established in very many places, and they greatly impede the progress of development, and through these conditions the small farmers that first make homes for themselves are bought out by great land companies who seek to control large volumes of water and large areas of land.

SECTION XIV.

INTERNATIONAL CONFLICTS ABOUT WATER RIGHTS.

The committee, in its travels through the arid region last summer, visited El Paso. While there the attention of its members was called to some serious international troubles arising through the use of the waters of the Rio Grande for irrigation in the El Paso Valley, a part of which lies in Texas and another part in the Republic of Mexico. Agriculture by means of irrigation has been practiced in this valley for nearly two centuries, on both sides of the river, and naturally the people believe that they have a prescriptive right to use the water to fertilize their lands, acquired by utilization through a long term of years. But during the past season the supply was insufficient for the usual purpose, and much suffering has arisen therefrom, and great farming values have been destroyed. In seasons of great rain-fall the water is sufficient to cultivate much larger areas than in seasons of small rain-fall. The permanent development of agriculture therefore depends upon the water supply afforded in dry seasons. In late years large areas of land have been cultivated on the Rio Grande in Colorado. There has also been a great development of agriculture in New Mexico on the tributaries of the Rio Grande. The effect of this is to cut off the water from the Rio Grande to a large extent, so that when dry seasons, like the last two, come, an insufficient supply of water is afforded by the Rio Grande to the people of the El Paso Valley, both in the State of Texas and in the Republic of Mexico. Immediately above the line between Texas and New Mexico there is another district of country known as the Mesilla Valley, which lies wholly in the Territory of New Mexico. Here, also, the supply of water was insufficient, from the fact that it had been cut off by irrigation above.

The committee found that the people of Mexico were complaining bitterly about the destruction of their agriculture, and the matter has now come to be an important international affair. This case illustrates others that must soon arise. The Colorado River of the west flows from the territory of the United States into the territory of the Republic of Mexico, and its waters can be used in either or both countries, and ultimately some equitable division must be made or international disputes will arise. In the same manner the waters of the Columbia and other rivers at the north, which are needed for irrigation, must be divided between the British possessions and our own; and at the present rate of settlement and development in that country these problems will soon appear and must be settled in some just and amicable manner.

SECTION XV.

CONFLICT OF RIGHTS BETWEEN STATES.

There is another class of difficulties arising the miscellaneous and unregulated appropriation of water and the use of rights through prior utilization. Unfortunately the arid region has not been divided into States and Territories by natural boundary lines, so that each drainage basin is under the jurisdiction of some one State or Territory. In the main, artificial boundaries have been adopted, described in terms of parallels and meridians. Through this unfortunate circumstance interstate interests are involved in the division of the waters. These interstate questions are numerous and of great importance, involving values of many millions of dollars.

Nearly all the great rivers and many of the great tributaries of the entire arid region and of the subhumid region, or more than one-half of the area of the United States, exclusive of Alaska, run through two or more States or Territories. In a few cases they are boundary lines; in others they head in one political division and run through another. In all these cases the waters must be divided on some equitable and wise principle.

In general the headwater States and Territories have it in their power to control the situation. They can take the water and laugh at the rights of the people lower down the rivers. The North Platte is to be divided between Wyoming and Nebraska; the South Platte, between Colorado and Nebraska; the Arkansas, between Colorado and Kansas; the Canadian River, between New Mexico and the Indian Territory; the Pecos, between New Mexico and Texas; the Rio Grande del Norte, among Colorado, New Mexico, Texas, and the Republic of Mexico; the Colorado, among Wyoming, Utah, Colorado, Arizona, Nevada, and California. All of the principal rivers of Nevada head in California. The Bear River is to be divided among Wyoming, Idaho, and Utah; the Snake is to be divided among Wyoming, Idaho, Oregon, and Washington; the Columbia is to be divided among Montana, British America, and Washington; the Missouri and its tributaries are to be divided among Montana, North Dakota, South Dakota, and perhaps Nebraska.

The lands are already divided by State lines, but they are practically valueless without water. The waters are flowing in the rivers and are to be taken out to serve the lands. The real value inheres in the waters. The lands, valueless without water, obtain a value of from \$25 to \$200 per acre with water. How, then, shall the waters be divided? It is a low estimate to say that the water values to be divided amount in all to more than \$500,000,000. The States can not divide the waters among themselves; the National Government must, therefore, become the arbitrator between them, and it should immediately intervene to divide the waters in some wise and just manner that will command the judgment of men. The importance of this matter can be illustrated on every hand throughout the arid region.

The principal rivers on which irrigation depends in the State of Nevada have their sources in the Sierra Nevada, within the boundary lines of the State of California. Nevada has but a small farming population, and this chiefly depends upon the waters of the rivers that come from California, and it is in the power of California to destroy the irrigation already established; that is, it is possible to divert the waters of these streams onto the mountain lands where grass and hardy vegetables

may be raised, but where the more valuable crops can not be produced. Again, if the agriculture on these streams—the Truckee, Carson, and Walker Rivers—is to be increased by the storage of waters, the reservoirs must, in the main, be situated in California. It is thus that the agriculture of Nevada can not be maintained by State authority. The time is not far distant when properties, having a value in the aggregate of many millions of dollars, will be in dispute between California and Nevada. Most all of the catchment area of the Snake River is in the Territory of Wyoming, where waters can be stored to irrigate several million acres of land. But all the good land lies in the Territory of Idaho. The right to the use of water for irrigation is prolific of disputes between the States, and every State and Territory of the arid and subhumid regions is involved. Rights have already vested to such an extent as to make the solution of this question difficult; but the near future will see them multiplied on a large scale.

SECTION XVI.

CONFLICT BETWEEN COMMUNITIES.

Everywhere in the arid region the scarcity of water is in contrast with the abundance of land, and out of this arise conflicts between communities. Along the course of a stream which will irrigate a few hundred thousand acres of land there may be a number of places where the water can be diverted to advantage. At each of these places headworks are constructed, and canals are made to lead the water therefrom to bodies of land, and in each case a group of farmers are dependent upon a single canal, and a number of canals give rise to a number of such communities, all having interest in the common waters of the natural stream. The rights between such communities are adjusted by a legal principle which has grown up in the States and Territories involved, which is styled the right of prior appropriation. In general this prior appropriation by canal is established when the canal itself is begun and a proper record of the same made. Prior appropriation in this case means prior construction of canal. As the communities grow and the agricultural area is enlarged by the prosperity of the people, a limit to this enlargement is reached.

If the principle holds that the canal appropriates to the extent of its capacity the earlier established communities may continue to expand until the capacity of their canals is reached. If the later established communities, having later canal rights, have in the mean time been using this water, they are cut off from its use by the development of the communities on the canals of earlier date. In this manner agricultural industries are established to be ultimately destroyed.

The larger streams originate in the confluence of smaller streams, and these smaller streams often have valleys where their waters may be used. It often happens that the waters of a larger stream are taken on the land first, and then settlements are established on the smaller and distant streams which take the water away. It is under such conditions that conflicts between communities arise, and as they involve the industries of the farmers and the chief values of the country, they are necessarily bitter. It has been proposed of late years to remove this cause of conflict by making the land instead of the canal the appropriator of the water. Should this rule be established it becomes necessary for the people of one community to watch the people of another, and to observe with great care the development of agriculture in every

district situated on the same principal stream and its tributaries, in order that no right may be established in conflict with existing rights. Unfortunately artificial county lines have been established, so that drainage basins are often divided, and county administration thus fails to provide sufficient remedy and regulation.

If the land instead of the canal appropriates the water, then every farmer's prosperity limits the prosperity of his neighbor, for as he develops his land by irrigation he secures rights to water which prevent others from developing their lands to the fullest extent. It is thus that the industry of farming by irrigation develops conflict and establishes a plexus of rights difficult to control.

If the annual flow of the stream were constant these difficulties would be greatly ameliorated, but dry and wet years occur. When great rain-falls occur for a series of years agricultural development is stimulated and the people irrigate a greater area of land than they are able to maintain when the dry years come. It is thus that in seasons of drought communities depending upon irrigation are plunged into conflict. The problem of dividing the waters of years of scarcity between the fields with justice to all is one of great difficulty. In older communities it has been solved in many ways, but they all provide an administration which has great power and which acts summarily in times of stress, leaving ultimate rights to be settled by the slower process of law in the courts.

SECTION XVII.

SPECULATIVE WATER RIGHTS.

It has been pointed out that in the arid lands the source of value inheres in the water; but such waters are forever flowing away, to be lost in the sands or swallowed by the sea. Hitherto waters unused have not been attached to specific lands, nor to any lands whatsoever. Any unused source of water might be seized by any one. In the local practice of the country it is only necessary to stake out a claim and have it recorded in order to make a seizure on such waters. Gradually in some of the States it has become necessary, in order to preserve the life of the claim, to do some work or make a show of some work on an irrigation structure. In this manner the streams of the arid region are being covered with claims for speculative purposes. When it is determined to actually construct irrigating works and thereby redeem definite bodies of land, these interfering speculative claims must be bought out. Such claims are numerous and are they held at great prices when bona fide works are to be constructed, and stand in the way of the actual development of the country, and if they are maintained their extinguishment will become a permanent tax on agriculture, as the selling value of such claims must be added to the investment or plant with which farming is started.

SECTION XVIII.

EXISTING WATER RIGHTS MUST BE MAINTAINED.

Already 8,000,000 acres of land are irrigated in the arid region. It seems probable, from the evidence brought before the committee, that works have been constructed capable of irrigating an additional amount of 2,000,000 or 4,000,000 acres. These people have redeemed their lands, have brought water upon them, and for that purpose have constructed

canals; and they have made homes, built themselves houses, planted their orchards, and inclosed their fields. Their rights are sacred and must be maintained, and nothing should be done to despoil them of the fruits of their industry. The larger part of the lands which have been selected have been wisely chosen and fall naturally into the irrigable tracts as described. Other lands have been unwisely chosen and impedimentary or obstructive rights have been established. Such rights can not be extinguished, even though they are impedimentary and obstructive, without just remuneration. It is therefore proper to declare all lands that have heretofore been irrigated in any district to be irrigable lands, but such rights should not be held for speculative purposes to coerce their purchase at exorbitant rates. It should be in the power of each community to extinguish these rights by public condemnation and due payment to the owners of the property.

SECTION XIX.

THE STORAGE OF WATERS.

The season of irrigation in the arid region varies greatly in length. In high altitudes and latitudes it is not more than fifty or sixty days in length, while in low altitudes and latitudes it may be four months in length. It also varies for different crops. But whatever its length may be it is still limited. When the streams are directly taken to the lands by means of canals, it is only during this season of irrigation that the waters are used; during the non-irrigating season the waters flow away to the sea or are lost in the desert sands. There are also floods, especially in the earlier part of the irrigating season, when all the waters of the streams can not be used. It is thus that a limit is established to the area which can be irrigated by the use of the seasonal flow of the streams.

The non-seasonal flow is utilized by storing it in reservoirs or great artificial lakes. The investigations made by the Irrigation Survey show that the non-seasonal flow can be impounded and used in the season of irrigation, often with great economy, and by this means the total area irrigated will be greatly increased—more than doubled. In the storage of water important conditions arise. This water should be stored in the mountains wherever possible, and such possibilities are frequent, as the mountain valleys often present favorable sites. When the water must be stored below, much more is lost by evaporation than when stored at higher altitudes. Under the most favorable circumstances there are not more than 40 or 50 inches of annual evaporation from a body of water in the mountains, while in the very low lands this evaporation is from 80 to 100 inches annually.

It must be further noted that all storage reservoirs must necessarily be at some distance from the lands to be irrigated, as the lands must lie at a lower altitude than the reservoir in order that the water may be conducted to them by canals. When the waters are stored in the mountains, far distant from the lands, they are discharged from the reservoirs, before being used, into the natural channel, to be taken out by the canals below. It is thus that the farmers on the lands far down the river must construct a large part of their storage basins in the mountains and away from home, and afterwards divide them among the canals below after they are commingled with the flow of the waters not dependent upon the storage basins.

If the reservoirs were on the low lands, near to the farms, then the waters would usually have to be conducted to them from the principal streams during the non-seasonal flow; so the waters would have to be divided among the reservoirs. Thus it is that when the waters are stored above they are divided after they are caught; when stored below they must be divided before they are caught. This makes it clear that some system must be provided for the division of the non-seasonal flow of the streams as well as of the seasonal flow.

SECTION XX.

THE DEVELOPMENT OF AGRICULTURE ON LANDS WHERE IT CAN NOT BE MAINTAINED.

As the water supply is limited and the land supply practicably unlimited, the unregulated selection of the irrigable land yields disastrous consequences, from the fact that lands are often irrigated where water rights can not be permanently maintained. If the lands first irrigated are low down on the course of a stream, irrigation above will take the water away; and this becomes a serious matter when the waters are taken away from a larger stream by using the small streams in detail on their own valleys. If this higher irrigation is in the mountains, it is a waste of water, as has already been explained, and the older settlements are destroyed by the newer, to the great disadvantage of agriculture at large. But this evil can usually be remedied by local legislation. When, however, the mountain lands are in one State and the low valley lands in another, the remedy is found with greater difficulty. It must necessarily be found in the powers of the General Government. If the lands first selected for irrigation are far down the stream, then the waters used are largely wasted on the way, and only a small area can be irrigated, even though the stream has unimpeded flow above; but if, after water rights are once established in the lower region, the waters are taken out far above on the lands where the supply is not wasted, very much larger areas can be cultivated; and it is difficult for the people below to maintain their rights to the full flow of the stream, which is chiefly lost before it reaches them; and if they could maintain their rights it would be a great disadvantage to the country at large, as it would seriously diminish the area of farming lands. When communities of different States thus build up conflicting rights, those below are entirely at the mercy of those above, unless the General Government intervenes to afford protection. It would seem to be unwise for the General Government, which still to a large extent possesses the lands, to permit the growth of industries on lands where they can not be maintained without a great sacrifice to the general interests.

There is still another condition, which makes this problem more serious. The volume of the streams being variable from year to year, there are seasons of plenty and seasons of scarcity. When seasons of plenty come, agriculture is rapidly developed in all of the communities; but when seasons of scarcity arrive, the established industries must suffer, either above or below, or in both places. Practically the suffering is experienced by the communities below. The Government of the United States is rapidly disposing of its lands, through the agency of the desert-land laws, timber-culture laws, pre-emption laws, and homestead laws, to settlers, who in most cases are required to irrigate them in order to obtain possession. Lands taken under the desert-land act

must be irrigated. Lands taken under the timber-culture act must also be irrigated if the trees are actually grown; and lands taken under homestead privileges must be made homes, if honestly acquired, and therefore they also must be irrigated. It is thus that the lands pass out of the hands of the General Government into the hands of individuals under a contract, real or virtual, that they shall be irrigated, and the Government in turn receives the money of the settlers for these lands. When farmers under contract with the Government to irrigate their lands do actually irrigate them and create conflicting rights, can the Government properly and honestly see the people of one community to whom it has sold lands despoiled by the people of another community to whom it has sold lands, all under contract that the lands shall be irrigated, which is the condition of spoliation? It is feared that such communities will believe they have a case in equity against the Government, and that, when their industries are overthrown, their homes destroyed, their property ruined, they will seek compensation from the General Government. If irrigation goes on unregulated for ten years more as it has during the last ten years, claims to the amount of hundreds of millions of dollars may be presented to the General Government. It is none too soon to consider this question. Already the basis of such claims is laid in many regions. At the present time the people of Kansas are developing lands of this character to the extent of four to five hundred thousand acres in the valley of the Arkansas, which, at the lowest rate at which irrigated lands sell, will be worth more than ten millions of dollars. Should poor men, ignorant of these facts, be permitted and encouraged to make homes on the public domain where they must ultimately be ruined? Will they not then come and beg of the Government for relief?

SECTION XXI.

AGGREGATION OF WATER RIGHTS AND LANDS IN THE HANDS OF THE FEW.

In the arid lands the fields are not fertilized directly from the rains. The water to serve them must be brought directly from streams having their sources in the mountains. For this purpose dams must be built, canals constructed, and reservoirs established. To do this work organized labor must be employed, and often great capital is necessary. A poor man can not go upon a tract of land and make a homestead for himself; he must combine with others to do this work, or with his neighbors to make a contract with some company to construct the necessary irrigating works. Often these preliminary works are of great cost, and before the first acre of land can be cultivated tens or hundreds of thousands of dollars must be expended—in some cases millions of dollars. It is through this condition of affairs that water rights are being aggregated in great companies; and when the water is limited and the land practically unlimited, the value primarily inheres in the water. This relates to the stream waters, on which the chief development of irrigation depends. Storm waters, pump-well waters, and artesian waters can, in the main, be managed by individual farmers, but stream waters require a preliminary outlay of money on a large scale. Under these conditions many irrigating companies have been organized. In the early history of irrigation in the West these companies laid claim to ownership in the water, but gradually, by legislation and judicial decision, this right of ownership has been greatly cur-

tailed, and the tendency seems to be to consider the canals as common carriers of water. In this manner the farmers are able, to some extent, to regulate the price at which waters shall be delivered to their lands. Still, the companies own the sites where the waters must be taken from the streams, and the lines of canals through which the waters must flow; and hence they own the right to deliver the water, though nominally they do not own the water itself. The companies also have it in their power to enforce their claims with great vigor, for if during the season of irrigation a field is deprived of its necessary supply of water the crop thereon is speedily destroyed; and when gardens, orchards, vineyards, and perennial crops are planted great values may be annihilated by withdrawing the water supply for a few weeks at the critical time.

Great increase is given to the value of land by irrigation, and with a desert claim before him the farmer is usually willing to make very liberal contracts to secure this increase in the value of his land. Hence it arises that the settlers make contracts with water companies at exorbitant rates, and usually these contracts are perpetual. When, in later years, it is found that the contract is improvident the farmers become discontented and a conflict arises between the users and the carriers of water, often disastrous to both parties. This unhappy state of affairs is greatly exaggerated by the conditions under which the water companies are organized. In the main they are developed by promoters, or middlemen, who make contracts with the farmers on the one hand and issue bonds to capitalists on the other, and who construct the works at great profit. For this purpose construction companies, or *credits mobiliers*, are organized. When the works are constructed the bonds or the stock of the companies, one or both, are in the hands of the capitalists, and lands in the hands of the farmers, and the promoters with their profits are gone. This condition is injurious to both parties whose interests remain, and the conflicts that arise therefrom are great and the resulting litigation is enormous.

Many water companies having met with disaster in this manner, the new companies were led to take warning, and another direction has been given to these enterprises. Here the companies attempt to make their profits primarily through the increase in value given to the lands, and the promoters go among the farmers and take options on their lands. When a tract sufficiently large for the purpose has been secured, the works are constructed and the lands bought. The companies then sell the lands at the increased value, with rights to the use of water and with contracts to furnish water perpetually or for a term of years.

The possession of the lands is sometimes obtained in another manner. The employes of the company and others are induced to make filings on the lands under the various acts of Congress for the acquirement of desert lands, timber-culture lands, homesteads, and pre-emption lands. Then to irrigate these lands the men who file on them enter into a contract with the company to furnish water, and mortgage their lands for this purpose. Sometimes the more thrifty settlers ultimately pay up these mortgages and possess their farms; but often, and usually, the mortgages are foreclosed after title passes from the General Government to the individuals, and the companies own the lands. In many cases this seems to be the understanding from the first, and nominal settlers are the agents of the companies, standing between them and the General Government. Large tracts of land are also aggregated in single holdings by purchase from railroad companies, and by the purchase of old Spanish claims.

It is thus that the farming values of the arid country fall into the possession of a comparatively few companies organized in the centers of trade in the East or in foreign lands. There are some very prosperous communities where such large possessions are not obtained, but where the people have settled on the desert lands in colonies and own the irrigation works. A number of such colonies have been founded in Colorado, greatly to the advantage of the people themselves. The people of Utah, under church regulation, have managed to control the waters used in irrigation by communities, and, in the main, the farmers themselves own the irrigation works.

The extent to which irrigation companies are being organized is very great throughout the entire arid region. To illustrate this fact an extract is here given from the report for 1889 of the Hon. L. Bradford Prince, governor of New Mexico. It is as follows:

A list is subjoined of the corporations formed for purposes of irrigation during the single year ending September 1, 1889. The most important operations now in progress are those of the Pecos Irrigation and Investment Company, in the valley of the Pecos. This company is now constructing two immense canals; the first being 40 miles long, 35 feet wide at the bottom, and carrying 7 feet of water, and the other, 45 miles below, being no less than 50 miles long, 45 feet wide at the bottom, and also carrying 7 feet of water. These are both to be fed by the Pecos, the flow of which is calculated to be 1,000 cubic feet per second. The intervening space is to be supplied by immense reservoirs; three of which are in process of construction; one being $1\frac{1}{2}$ miles long, three-fourths of a mile wide, and 12 feet deep; one $1\frac{1}{2}$ miles long, 1 mile wide, and 18 feet deep; and the largest, which merits the name of a lake, being $7\frac{1}{2}$ miles long, $2\frac{1}{2}$ miles wide, and 40 feet deep. This vast work will cost about \$1,000,000, and it is expected to irrigate between 200,000 and 300,000 acres of land. No one can even imagine what New Mexico will produce when her immense acreage of fertile soil is brought under cultivation through enterprises of this kind.

List of corporations for irrigation.

Corporation.	Locality.	Corporation.	Locality.
Reservoir Irrigating Company.	Near Navajo Springs.	The Dark Canyon Ditch Company.	Lincoln County.
The Pecos Valley Land and Industrial Company.	West side of Rio Pecos, in Lincoln County.	Springer Land Association.	Colfax County.
The Pecos Irrigation and Investment Company.	Lincoln County.	The Lincoln County Ditch Company.	Rio Hondo, Lincoln County.
White Oaks Development Company.	Do.	The Spring Valley Ditch Company.	Lincoln County.
Pefiasco Tank Irrigating Dam and Ditch Company.	Do.	Perry Fountain Ditch Company.	Do.
The Union Ditch Company.	San Juan County.	Albuquerque Irrigating Canal and Land Company.	East bank of Rio Grande in Bernalillo County.
The Guadalupe Valley Ditch Company.	Lincoln County.	The San Juan Water Company.	San Juan River, San Juan County.
The Rio Chama Mining and Improvement Company.	Rio Arriba County.	The Fort Sumner Land and Ditch Company.	Any place within the Territory.
The Detroit and Rio Grande Reservoir and Pipe Line Company.	Doña Ana County.	The Roswell Water Company.	Roswell, Lincoln County.
Lower Felix Ditch Company.	Rio Felix, Lincoln County.	The Dark Canyon Water Company.	Lincoln County.
The Bowman Irrigation Company.	Lincoln County.	The Mountain Irrigation Company.	Do.
The First New Mexican Reservoir and Irrigation Company.	Do.	Una de Gato Canal and Irrigating Company.	Not specified.
San Juan South Side Canal Company.	San Juan County.	The Santa Cruz Land and Irrigation Company.	Rio Grande, between La Joya and Santa Cruz.
Lincoln Acequia Company.	Lincoln, Lincoln Co.	Jicarilla Mining and Water Company.	Not specified.
The Guadalupe Valley Irrigating and Milling Company.	Lower Rio Pefiasco.	The La Plata Ditch Company.	Do.
The Pecos River Ditch Company.	West side Pecos River, terminus near Salt Creek.	Rio Puerco Irrigation and Improvement Company.	Bernalillo County.

In the same manner water companies or irrigating companies whose purpose it is to acquire water rights only, or acquire water and land titles, are being organized in every State and Territory where irrigation is necessary; and these organizations are on a large scale and have no difficulty in securing capital necessary to their enterprises by reason of the great value given to the lands through irrigation. It is probable that companies have already been organized to take out more than three quarters of all the stream waters of the arid region. But these companies, in the main, have been organized since the passage of the act of October 2, 1888, by which the sites for head-works, canals, and reservoirs are reserved in the hands of the General Government, and by which the irrigable lands commanded by the waters are reserved for homestead settlement. It is thus that a vast body of companies stand ready to seize upon these waters and lands, and are now attempting to undo the legislation already accomplished in the interests of the people.

The effect of organizing irrigation companies on a large scale in this manner is to stimulate inordinately the development of agriculture by irrigation on the arid lands. To obtain laborers on the works and settlers on the lands the companies often organize immigration bureaus, and thus bring into the country great numbers of people, especially foreigners. All this tends to rapid development, but it is an unhealthy state of affairs. It is believed that the normal development of the country, through the agency of settlers who are enterprising and desirous of making homes for themselves, will be more in the interest of the country and will result in greater prosperity than if the settlement and development of the country should be put into the hands of promoters or middlemen. It is believed that if the settlement of the West should be placed in the hands of these irrigation companies, an era of wild speculation would be inaugurated in which hundreds of thousands of people would be involved, that vast numbers of people would speedily be attracted to the arid lands, that agricultural industries would be developed beyond the needs of the country, and that these stimulated industries would ultimately collapse, involving many in ruin, while the promoters of these schemes would secure great wealth, chiefly through the agency of construction companies and the sale of bonds.

SECTION XXII.

IRRIGATING WORKS SHOULD NOT BE CONSTRUCTED BY THE GENERAL GOVERNMENT.

The statement has been repeatedly made that a great increase is given to the value of land by conducting water to it. The primary cost of conducting waters to lands greatly varies under the differing conditions. It is usually from \$2 to \$10 per acre. But as a result of this outlay the lands themselves are greatly increased in value, from \$25 to \$200 per acre. The increase in the value of lands ought to be used for their redemption, and it is amply sufficient; in fact, there is always a surplus, which is an unearned increment, and to the members signing this report it seems just that the farmers themselves should be the persons to reap this harvest of values. Especially should great care be taken by the General Government to develop a land system for the disposition of its public domain by which this result may be secured. The arid lands of the West should not become the theater of exploitation and speculation, as they are now becoming, and should

not fall into the hands of large owners; nor should middlemen be able to reap the great rewards which the redemption of the land involves. All these advantages should accrue to and be distributed among the great army of settlers who are to till the soil. The many should be benefited rather than the few, the laborer rather than the promoter.

SECTION XXIII.

IRRIGATION DISTRICTS.

Nature has divided the arid lands into districts which are usually well defined. The entire region is composed of drainage basins, and through the midst of each one flows a stream, and it is bounded above and on either side by the crest where the waters divide. Such a district, therefore, is natural, and in such a district all of the conditions for prosperous agriculture exist and are unified. Let us take a single district for an illustration:

The Big Thompson, of Colorado, is a stream which flows into the South Platte River. It heads in the Front Range of Colorado, and its basin is there sharply divided by the crest of the mountains from the basin of Grand River, which flows westward into the Colorado. On the north the Big Thompson basin is sharply divided from the basin of the Cache la Poudre, and on the south in like manner it is separated by a sharp ridge from the basin of the St. Vrain. The Cache la Poudre and St. Vrain divides converge in the direction of the South Platte. In the direction of the Platte River the Platte Valley itself clearly marks the limit of the Big Thompson basin. Now within this natural basin, thus plainly demarkated, we have, first, in the mountains and foot-hills above, on either side, a great catchment area. Below, in the valley, there is a fine body of irrigable lands upon which the waters of the catchment area may be used. All of the waters of the Big Thompson can be used in this valley, and yet it will not all be redeemed. There will, therefore, be left large areas of pasturage lands which the farmers on the irrigable lands could utilize to advantage. Then on the foot-hills and mountains of the catchment area there are great forests, which are rapidly being destroyed, to the injury of the farmers below: first, because the sources of their water supply are being destroyed; and second, because they need the timber to use on their farms. Therefore they are the people interested in the preservation of the timber and in the protection of the grass lands. And the people who are farming in the lower valley of the Big Thompson are also interested in the mountains, from the fact that the reservoirs to hold the waters for their farms must lie in these mountains and in the foot-hills.

Here, then, we have a body of irrigable lands sufficient to support a large population, aggregated in the midst of a valley, and about them grass lands, timber lands, and a catchment area for the water which they use. It is a natural division of the country, and all the people who dwell in the valley and live by farming are interested in all parts of the catchment area, for the waters which fertilize their fields are derived therefrom and can not be divided until they are caught in reservoirs and carried in canals, which all the people must unite to construct, either directly through their own labor or indirectly through the employment of water companies. It is thus that the basin of each of the great creeks and small rivers of the arid lands is a natural irrigation district, and the people in each one have a common interest in the entire district, because it is the catchment area for their waters. All

such headwater districts are called by Director Powell districts of the first class, and in them are found the greater part of the irrigable lands of the arid region.

But there are still other natural districts. The great rivers, which are formed by the union of many creeks and smaller rivers, flow on for long distances and ultimately pass out of the arid lands or reach the sea. The division of the lands lying along the trunks of these streams when the headwater districts are all laid out gives rise to a second class, which the Director of the Survey calls river-trunk districts. It is usually the case that such a river in its course has in one reach a valley stretch on either side and in another high table-lands through which it runs in a deep cañon, or high mountains on either side. These high table-lands or mountains form catchment areas which enlarge the volume of the trunk stream, and each catchment area has below it a stretch of valley land that can be irrigated, so that we again have high catchment areas above with low valleys of irrigable lands below. It has been found by the Director, who seems to have studied the subject carefully, that all of the great trunk streams can be thus divided into natural districts, with catchment areas and irrigable lands in each, but that in a few places it may be necessary to establish artificial lines as boundary-lines.

In the arid region there are many streams whose waters do not flow to the sea. The streams, gathered in mountain catchment areas, roll down the valleys and are lost in the sands, or, as they are locally called, "sinks," where such waters are evaporated. When streams disappear in this manner, never to appear again at the surface, it is often popularly supposed that underground rivers exist, but there is no foundation for this popular error, as it is well known that the rivers are caught by the sands and evaporated, a sand plain constituting a more efficient evaporating surface than a body of water. These streams which do not roll on to join others are in the West known as "lost rivers," and Director Powell calls the natural districts which they constitute lost-stream districts.

There are thus three classes of natural basins, which constitute three classes of natural irrigation districts, and it is possible to divide the entire arid region into districts of these classes. Now it is proposed to take advantage of these natural conditions to aid in the solution of the problems which the new industry of agriculture by irrigation presents.

As a further illustration of this matter, the following quotation is made from the statement of Director Powell to the Special Committee on Irrigation, printed on pages 22 and 23 of Volume IV of their report:

I place before you to-day a map of the Rio Grande, including all the area drained by that stream north of the Texas line. There are some important facts relating to the utilization of the arid lands which can be well elucidated by considering that region of country, and I present the map again for that reason. In talking to you about the irrigation problems presented in the valley of the Arkansas, I called your attention to the fact that that valley could be divided into districts, each one an independent unit. The whole arid region may be divided in like manner into natural districts or drainage basins, each one of which has its problems so interwoven that the entire district must be so considered in planning its system of irrigation works, but which is practically independent of all other districts. These hydrographic basins, as I call them, are of three classes, viz, headwater districts, river-trunk districts, and lost-stream districts. The headwater districts commence in the mountains and extend down the streams far enough to include catchment areas and farming areas. These headwater districts are not only found on the main streams, but on all perennial laterals or tributaries. Usually each lateral or tributary forms a natural district by itself. But the great rivers flow on across the plains and down the great valleys, and their trunks must be divided into districts, each one of which presents an independent system of works. These I call river-trunk districts. Then in the arid lands there are many streams which do not flow into great rivers and ulti-

mately to the sea, their waters being lost in the sands or emptying into salt lakes. These I call lost-stream districts. All of these classes are represented in the Rio Grande region, the map of which is before you.

In considering this subject and planning the work of the Irrigation Survey, it has been found that a natural district or hydrographic basin must be considered as a unit in which all the problems must be solved. In order to report upon the district and recommend a plan of works, we must know in such a district how much water will be supplied for irrigation, where the diverting-dam sites, reservoir sites, and canal sites are situate, and where the lands to be irrigated lie. And it has been found, after a careful examination and from the best data we have on hand, that there will be one or two hundred such districts in the arid region, and that if the survey is carried out it will need a separate report on each. I have therefore found it necessary, for the administration of the survey, to consider these hydrographic basins, and have been studying them for some time—in fact for years before the survey was organized, for I early recognized that ultimately these natural features would present conditions which would control the engineering problems of irrigation, and which would ultimately control the institutional or legal problems. The study which I have made in the survey in this direction of course can not be considered final. An actual survey on the ground is necessary to define the limits of each basin, and a very careful survey is especially necessary to define the limits of the trunk districts. The headwater districts, or those of the first class, and the lost-stream districts, or those of the third class, are quite easily discovered; but the districts of the second class require very careful study for their determination. The meaning of this will more fully appear from the illustrations which I am able to present to you to-day in considering the Rio Grande Valley.

First, we have the Saguache River, a river with tributaries—a number of beautiful creeks. The river flows into a sink, and the drainage is lost in the sands. Now, the utilization of that water affects that valley only. It is independent of all the other regions of country. The region of country at the sink is one of sand, and it sinks in these sands and is evaporated. It is only on very rare occasions, many years apart, that there will be a great flood which will cause it to overflow and open a channel to the Rio Grande. In all ordinary years all the water which is used must be in the valley here [indicating], hence it is an independent basin. This is what I call a district of the third class, a lost-river district. It will be noticed that in this district the people who engage in agriculture here can not possibly have any conflict about water rights with the people of any other district. They may use all of this element which they can catch and spread it upon their lands, and nothing will be cut off from any other district; nor can they obtain water from any other district to put upon their lands. And they are interested not only in the water; they and they only are interested in the forests about the fountains whence their waters come, and they are the people who should be interested in the grasses which grow in the valleys and on the hills and mountain slopes.

The Saguache district, therefore, is clearly defined in nature. Its boundary is marked everywhere by the parting of the waters.

Passing over to the Rio Grande proper, we have the San Luis district, which is also a headwater district. The San Luis Park is a beautiful tract of land, and high mountains stand around it and gather great quantities of water. This is a region lately redeemed for agriculture, but already all the flow of critical years with extreme dry seasons is used in agriculture, and the companies that are specially interested in these water rights are preparing to store and use all its waters which flow through this season. It may be possible that they can use all and that the area of good land to be cultivated will be sufficient. We do not yet know the amount of water that flows in the streams, nor do we know the amount of good available land. Be that as it may, we are able to state that this great district is a unit, and that it must be considered as such in planning the proper system of irrigation works, and that its people will be as a body interested in the management of its waters, its forests, and its pastures. And they are the only people to be interested except to this extent, that if the waters are not used here they will flow into trunk districts below, to be used there. If the people of the districts below, in New Mexico, could lay an embargo upon irrigation in the San Luis Valley, larger areas in New Mexico could be cultivated, but the loss of water on the way would be such that they would not equal in area the lands that could be irrigated in Colorado. It is therefore manifest that it is to the advantage of the agricultural interests of the country that the people of Colorado who live in the San Luis Valley should be permitted to develop their agriculture to the utmost, and use all the waters that they can put upon good agricultural lands.

The Rio Grande, in crossing the line between Colorado and New Mexico, enters a cañon and flows for about 50 miles through the gorge, and its waters can not be taken out along this stretch. This cañon ends where Taos River, coming from the east, joins the Rio Grande. The Taos is a beautiful stream and all of its waters can

be used in its own valley. All that run during the season of irrigation and all that run throughout the year can be stored, so that the waters of the Taos may ultimately be cut off from the Rio Grande.

The region of country on either side of the cañon of which I have made mention—Embudo Cañon—has lava-fields and is not agricultural; but some fair timber grows there and much water comes down into the cañon, so that when the river emerges into the valley at the foot of Embudo Cañon it is a fine stream, and must always be so whatever water is taken out in Colorado above. Some 40 or 50 miles below the river enters another cañon. Between these two cañons lies the valley of San Ildefonso, into which come some small creeks from the east, and the water of the Rio Grande can be taken out at the foot of Embudo Cañon and spread over the San Ildefonso Valley and make here a river-trunk district, or district of the second class. This is a district also well defined in nature. Its catchment area is lava-fields above and mountains on every hand, and its irrigable or farming area is the low valley stretching back from the Rio Grande on either side.

Near the foot of San Ildefonso the Chama enters from the west. The Chama is a large river for that country, and its smaller tributaries drain great mountains, and there are many beautiful valleys scattered about through the region. The lower portion of the Chama runs through a sand plain, and these sands are volcanic ashes which drift and blow into the river and fill it with sediment. The Rio Grande above the mouth of the Chama is a clear, beautiful river, but at the mouth of the Chama it is transformed by the mud of the Chama itself. It then becomes a river of mud and continues such to the Gulf, as it takes up sands along its way. The Chama Basin is another natural basin, having timber lands, pasturage lands, and agricultural lands.

At the foot of San Ildefonso Valley the Rio Grande enters White Rock Cañon and continues its course through a deep gorge for 40 or 50 miles. Along this course its waters can not be used for irrigation. The cañon walls are hundreds of feet, and in some places more than a thousand feet, above the waters. But the high volcanic plateau on the east furnishes a notable amount of water to this stream, and on the west there is a group of great volcanoes from which many beautiful streams flow; so that if all the water should be cut off at the head of White Rock Cañon, there would still come into the Rio Grande, through the course of this gorge, a vast body of water to be used below—water which can not be used elsewhere, as none of the streams above on either side of the cañon have agricultural lands along their courses. But they have great forests. Here some of the finest forests of New Mexico are found. This is the great catchment area for the valley below White Rock Cañon.

Some flood waters will always come down the Rio Grande from San Ildefonso Valley, however thoroughly the country may be utilized, and additional water will be caught in the cañon itself, and so the valley below will have a good supply. White Rock Cañon empties below into a valley which I shall call the Albuquerque Valley. In it lie Bernalillo, Albuquerque, Los Lunas, Socorro, and other towns. Now, all the water that comes out of White Rock Cañon can be used in the Albuquerque Valley, as it may be diverted below the White Rock Cañon and carried out and stored on the flanks of the valley. There is now much agriculture in this valley, and some of it is very ancient. Including the catchment area about White Rock Cañon and the hills and mountains on either side, and the valley where agriculture can be carried on, we have another natural district or hydrographic basin—a district of the second class, or stream-trunk district. Now, it will be seen that all the water to be used in this great valley comes from the mouth of White Rock Cañon. Whoever has control of that point—owns that dam site and has the right to take the water out of its natural channel and carry it into canals—has command of all the agriculture of that great district.

I wish to explain further that the people who have settled here have taken out the waters of the Rio Grande and utilized them during the season of irrigation, but they have not yet resorted to storage and the waters which they use are used to very poor advantage. The flood-plain, or strip of country next to the river, which is sometimes overflowed, is broad and sandy; the river itself is shallow and is a river of mud, and it is very wide; so it flows into these sands and is evaporated to a very large extent and thus lost to agriculture. Then the people have constructed low-line ditches near to the Rio Grande and take out the water by a system which is exceedingly wasteful and which is destroyed more or less with every flood. Ultimately they will find it to their advantage to take the water higher up, near the mouth of White Rock Cañon, and carry it out by high-line canals and store the surplus in the lateral valleys. By this means the area of agriculture in the valley can be increased five or ten fold.

It is possible to take all the water of the Rio Grande there during the season of irrigation. It is also possible to take out all the water there during the non-irrigating season. If the water for the non-irrigating season is to be stored, you are compelled to take it out there. You can not take it out by the present ditches, for they do not flow

on high enough ground; but if a canal is constructed from the mouth of White Rock Cañon, and a diverting dam built there and lakes made—there are good places—all the water could be used in the valley. So, not only is it necessary to take the water out at that one point and utilize the entire flow during the season of irrigation, but it is also necessary to take it out at that point in order to store the water which now runs to waste. So that if the water is taken out at this one point of which I speak, altogether, the area of irrigation will be multiplied ten times. But that can not be done without considering the rights of the people who now use some of the water by improvident and obstructive dams.

Off to the east here, as you see on the map, is the Santa Fé Creek, on which the city of Santa Fé is situated. It also constitutes a distinct basin, with irrigable lands, timber lands, and pasturage lands, and all its waters can be caught and used in the Santa Fé Valley, so that no considerable amount will ultimately flow from the Santa Fé Creek into the Rio Grande.

On the west we have the Jemez River, where another natural district of the first class is found. The Jemez River drains the Tewan Mountains and plateau. The catchment area is well wooded. Fine forests are found and great mountain meadows are seen, but the land above is cold and is not valuable for agriculture, except for pasturage, and perhaps a little hay may be cut with advantage. The many streams which head in the Tewan Mountains and plateau find their way into deep cañons. On leaving the mountains nearer Jemez Pueblo the whole body of the stream can be taken out and put on the mesa above Albuquerque, or west of Albuquerque and Bernalillo. It is another natural hydrographic basin of the first class.

Below Albuquerque we have the Rio Puerco. All of its waters can be used in the upper portion of its valley, and there is much more land than the water will serve. Very little water ever runs into the Rio Grande from the Puerco, and that comes only at flood-time. It is a hydrographic district of the third class, with irrigable, timber, and pasturage lands, and with many fine sites for reservoirs.

Where the Albuquerque district should end and the next district, embracing the Mesilla Valley and the El Paso Valley, should begin, I am not able to state, but from such information as I have been able to collect, I believe that below Socorro a new natural division can be made.

Let us go on to consider the region of the Rio Grande below, from Socorro to a point on the river 30 or 40 miles below El Paso. Here there are two valleys, Mesilla Valley above El Paso and the valley below, a part of which is in the Republic of Mexico and a part in Texas. Now it is possible to cut off from these two valleys all of the waters which flow during the season of irrigation in critical years and destroy all the agriculture in those two valleys unless the waters of the non-irrigation season are stored. During the non-irrigating season large bodies of water come into the Rio Grande from the mountains on either side. There are high mountains to the west and high mountains to the east, but there are few perennial streams, and they are only small creeks. The principal body of the water comes in as storm water. But the area is pretty large and its waters can be stored immediately above El Paso and at the head and along the flanks of the Mesilla Valley. At the Point of Rocks, at the head of Mesilla Valley, all of the waters of the Rio Grande can be captured again and they can be taken out into the Mesilla Valley and used once more.

The waters of the non-irrigating season can be stored on the flanks of the valley, and there is more land than all the waters will serve. Still there is a mountain catchment area on either side of the Mesilla Valley, the waters of which will flow through the valley at El Paso at flood times, and these waters can be stored to be used in the valley below in Texas and Old Mexico. But I do not think there is enough of these waters to support all the agriculture now developed if the waters of the Rio Grande are all taken out at the Point of Rocks. To maintain the irrigation now developed in the El Paso and Mesilla valleys, some division of the waters must be here made. The catch from Socorro down, coming from the mountains on either side, and the surplus which may come down in great floods from the Rio Grande above, must be divided between the Mesilla Valley and the El Paso Valley to maintain the agriculture already established, and to give some development to the same. Just how this can be done to advantage is not known; the topographic survey has not proceeded far enough. We know where the waters can be stored for the El Paso Valley, and I have already explained that to the committee some days ago. We can create a great reservoir with reasonable economy immediately above El Paso; we can also create a reservoir, or series of reservoirs, in the Mesilla Valley; but how much water can be caught and held in these reservoirs we do not know, and can not know until the topographic survey is completed, for on that we depend to determine the water supply.

It is safe to say, however, that the reservoir at El Paso may be constructed, and I incline to think that the rights to the present irrigation in the Mesilla Valley may be maintained, the rights in the El Paso Valley maintained, and that irrigation in both districts may be increased—but to what extent and to what size these reservoirs

should be constructed is yet unknown. It will require another year's survey to determine these facts. This, however, is certain, that there can be no development of irrigation in these valleys through the use of the waters of the irrigating season only; in fact the present agriculture can not be maintained unless the waters are stored. The irrigation already developed in Colorado and the upper valleys of New Mexico is destroying the agriculture here. Two more years of development will cut it all off when dry seasons come. The only hope for these valleys is through storage, and how the entire problem is to be solved by storage is not yet known. Nor can it be done without some interference on the part of the United States. If the General Government does not step in and by definite legislation assign specific waters to El Paso and the Mesilla, the El Paso Valley will surely be destroyed, and the Mesilla Valley can be almost ruined by the people of the Albuquerque Valley. What is needed is the construction of storage reservoirs and their protection, and the assignment of specific catchment areas to those reservoirs. The Government must say that a certain catchment area can be used for the Mesilla Valley and that the remaining catchment area can be used for the Albuquerque Valley.

A State, a Territory, and a foreign country are involved, and they can not settle the problem for themselves. There is only one way to protect this ancient irrigation in the El Paso and Mesilla Valleys and their right to use the water of the irrigating season, and to proceed as they have heretofore done without storage, and that is to destroy all irrigation in Colorado and all of the lately developed irrigation in the valley of the Rio Grande in New Mexico above, and to prohibit forever the use of the waters there; and this would mean that to maintain seventy-five to one hundred thousand acres of agriculture, several million acres of development must be stopped. Of course this can not be done. They must resort to storage, and somehow storage rights must be fixed and maintained.

The area drained by the Rio Grande above El Paso is a little more than 23,500,000 acres, or about 37,000 square miles. But much of the region is mountainous. Even if there was water enough it would not be possible to irrigate one-half of the land; of the arable lands only a portion are irrigable, from the fact that there is not water to supply them all. It may be that when all the waters of the Rio Grande are used in Colorado and New Mexico and in the valley of El Paso, in Texas and the Republic of Mexico, from three to four million acres can be cultivated; but this can be done only by using all of the waters and storing all those that now run to waste. And then the irrigable lands must be properly selected, so that the waters can be used to the best advantage. That none may be wasted they must be stored where there is the least evaporation, and the lands must be selected near where they are stored, and the waters must not be permitted to run through sand valleys, where they are evaporated. They must be taken out from the streams and stored to the best advantage and used without waste. Then it may be possible to irrigate from three to four million acres. Of course the estimate is rough, because the surveys have not been perfected, and it may be too great; I do not think it is too small. Now the problem which you ask me to solve is this: How can these waters be used to the best advantage; how can they be divided among the best lands; and how can the rights of the present irrigators be maintained? I shall try to answer these questions, and certain collateral problems that are involved; and to do so, shall go over the ground again, district by district.

Commencing then at the head of the Rio Grande Valley, we first meet with the Saguache. This river sinks in the sands; except in very great floods it discharges no water into the Rio Grande. Its valley therefore is an independent district, one of the minor class; all that can be done in the Saguache district is to select the best irrigable lands and provide that the waters shall not be used where they will be largely wasted.

Then we have a district drained by the headwaters of the Rio Grande—a district, of the first class. All, or nearly all, of its waters can be used within the district on good lands, but they must be selected or the waters will be wasted. The district lies wholly within the State of Colorado.

The next district below on the river is the San Ildefonso. This is a trunk district and thus belongs to the second class. For 60 miles down below the Colorado line the river can not be taken out, as it runs in a cañon. The lands on either side are of little value and should be used only for pasturage and forest purposes. This upper portion of the San Ildefonso Valley is naturally the catchment area for the waters to be used in the valley below the mouth of Embudo Cañon. There are some creeks that come into this valley from the mountains on the east. This district, therefore, has a great catchment area which will supply a large quantity of water, which should be dedicated to the use of the farmers of the valley below. But they should understand that they can not maintain rights to use water coming from the San Luis district; that they should develop their agriculture wholly from the supply of their own catchment area. The best lands lie on either side of the river in the valley below Embudo Cañon and along sections of the eastern tributaries. These lands

should be selected in sufficient amount to use all the water for irrigation, then there could be no controversy about the water-rights in the district. Settlers could not go upon the non-irrigable lands and illegally take the water; farming could be developed in the valley to the greatest extent and on the best lands, and the farmers would be secure from depredation by other farmers going above them and "pirating" the water—to use a term common in the western country.

Midway in this district, and at the head of the irrigable lands, the Taos joins the Grande. It is a fine stream and its drainage basin constitutes a district of the first class. All the waters of the Taos can be used in its own valley, and it should be established that the people of that district have a right to use all of those waters, and that the people in the San Ildefonso Valley below can never maintain the right to have those waters flow down to their valley; that the Taos Valley is not a part of the catchment area of the San Ildefonso Valley.

In the lower part of the San Ildefonso Valley the Chama joins the Rio Grande. The basin drained by this river constitutes a district of the first class. All its waters can be used at home, and it should be established that the people have a right to use them there, and that no right can be maintained to the use of its waters outside the district.

At the foot of San Ildefonso Valley the Rio Grande enters a deep cañon, known as White Rock Cañon for a course of 50 miles. Along this course it receives many important tributaries that drain high mountains. This mountainous region is in part covered with timber and in part with rich grasses, and it constitutes a catchment area for a district below. At the mouth of White River Cañon the waters can be taken out again and spread over a large valley. In this valley there are already a number of considerable towns. Albuquerque is the principal city, and we will call it the Albuquerque Valley, and the district, including the valley and the catchment area above, the Albuquerque district. It is, of course, a trunk district, and hence belongs to the second class.

Now, it should be established that the people of the Albuquerque district can not maintain rights to use water not caught within their district; that all the volume of the Rio Grande in the San Ildefonso above belongs to the people of that valley; that the only waters which the Albuquerque farmers can use and permanently maintain rights to are those falling from the heavens over their district. The irrigable lands of the Albuquerque district are in excess of the water supply. The nearer to the mouth of the White Rock Cañon they can be used, the greater the area that can be irrigated. Perhaps this district should terminate at Socorro. Perhaps it should go down to San Marcial. A careful topographic and hydrographic survey is necessary to determine this boundary. The district would at any rate be more than 150 miles in length, and it is a long sand basin. If the irrigable land should be selected in the southern end of the district, much of the water would be lost on its way; if it is selected in the northern end of the district, this water could be saved. The Rio Grande will irrigate 200,000 acres in the northern end of the valley. But there are lands already irrigated in the southern end of the valley, and their rights should be maintained, at least until they are justly extinguished. Doubtless this will ultimately be done. It is of prime importance that no more right be established in the southern region of the district.

To the east of the White Cañon lies Santa Fé Creek. It is a beautiful stream of water, and the region which it drains forms a district of the first class. Here the city of Santa Fé is situated, and the waters of the great creek are all used in irrigation during the summer months. An attempt has been made to store water, but it has proved a failure. The site of the reservoir was among hills that had been denuded of their forests and grasses, and the reservoir was destroyed by the enormous and rapid accumulation of debris. Other and better reservoir sites have been found where the forests are not yet destroyed. The farmers of the district should have control of these forests, or they can not greatly increase the area of irrigation in the district. The lands to be irrigated lie on a plateau in the neighborhood of the city and are already of great value. The principal catchment area is in high mountains where there are extensive forest lands and where there should be pasture lands, but these are largely destroyed by overfeeding. The pasturage and timber lands greatly need protection in the interests of agriculture below.

Just above Bernalillo the Jemez joins the Rio Grande, and here we have another district of the first class. The Jemez now discharges a part of its waters into the sand, for there is a long stretch of dunes extending from Zia down to the Rio Grande. Still the river has a volume sufficient to carry part of its waters over the sands and discharge them into the Rio Grande. The catchment area is the Tewan Mountains and the Tewan Plateau, a lofty region covered with beautiful forests and rich grass lands yet uninjured by fire or overfeeding. The mountain meadows are abundant and beautiful, and the forests are among the best in New Mexico. The lands to be cultivated by this river lie on the mesa west of the Bernalillo and Albuquerque. The waters can be stored in the mountain meadows and elsewhere very

cheaply, but it will be expensive to take the water across the sand dunes on to the irrigable lands of the mesa. The mesa itself and the catchment area both should constitute one district. The waters of the mountains should be attached to the lands of the mesa, and the right to use the water should permanently inhere there. The settlers in the valley of the Rio Grande should not be able to acquire rights to the waters, for in so doing they will be chiefly wasted. The catchment area is a volcanic district, and volcanic cinders and ashes abound; and these conditions make it necessary to carefully protect the lands, otherwise they will sink the streams and fill the reservoirs. The forest area is therefore chiefly valuable as a catchment area, and which should never be denuded of its trees.

The next stream is the Puerco, which comes in below from the west. It heads in the Nacimiento Mountains, on the western slope of the Tewan group. Along this range of mountains there are several beautiful streams that flow into a distant valley into the channel of the Puerco and here land in the sands and pass only in extreme floods into the Rio Grande. Practically it is a district of the first class. Its waters have been used in irrigation in the settlements near the mountains, which are, to some extent, well situated for such purposes. But farming is chiefly carried on in the valley of the Puerco, and in that region can not be permanently maintained to advantage. The rights to irrigate so far from the mountains must be permanently extinguished if the Puerco is used to the best advantage. The catchment area is the slope of a great mountain range covered with fine forests, and there are many good reservoir sites. The pasturage is also extensive, but the pasturage and the forests must be protected to save the agriculture. The irrigable lands of the Puerco should be carefully selected and no other lands should be cultivated. The reservoirs must be selected in the valleys and on the slopes of the mountains, where they will be subject to destruction by silting if the forests and grasses are not carefully preserved.

From Socorro southward to El Paso is a distance of about 200 miles by the river. There is already irrigation in the Mesilla Valley above El Paso, and there is also much farming below El Paso in Texas and the Republic of Mexico. Through much of the way from Socorro to the head of the Mesilla Valley the river cañons again, and there is a natural catchment area for the country below. This upper region should be declared the catchment area for the Mesilla Valley. At the mouth of this cañon there is a place called Point of Rocks, near Fort Selden. Now it is possible to take out all the waters of the Rio Grande derived from the catchment area above, which has already been described at this point, and there is land enough in the Mesilla Valley to use it. But this would cut off all the water from the El Paso Valley below. There is a short pass or gorge just above El Paso through which the Rio Grande runs. This divides El Paso Valley from Mesilla Valley. To maintain the rights of the present irrigators in Mesilla Valley and El Paso Valley alike, it becomes necessary to unite these two valleys into one district, and to divide the waters between them. There is water enough coming in the catchment area described to maintain all the agriculture yet developed and to increase it somewhat. How much we do not know, as the survey is unfinished. Nor do we know how to divide the waters. The El Paso Valley is partly in Texas and partly in the Republic of Mexico. The Mesilla Valley is in New Mexico. It is thus that the waters of the Rio Grande in this district must be divided between three peoples, and unless some authority steps in and makes this division the irrigators of the Mesilla Valley can take all the water and destroy all the farming below in Texas and Old Mexico.

The survey has developed the fact that we can store water with reasonable economy and in sufficient amount immediately above El Paso, at the gorge of which I have spoken, to supply the wants of all the farming in the valley below in both countries, and from the same reservoir an additional area can be served; but there is no wisdom in constructing this reservoir unless steps are taken to provide a catchment area for it, and to protect that catchment area from spoliation. It is thus that the El Paso problem can not be solved by the construction of a dam at El Paso and the establishment of a reservoir to hold water for the valley below. A catchment area must be provided, and on providing this the rights of the Mesilla Valley must be maintained. It is true that if the dam is constructed at El Paso now, flood waters in sufficient quantities will come down to serve present wants, but these flood waters can be caught above, and ultimately will be caught above, and it would be unwise to pay no heed to the ultimate conditions. How many years ere this will be I do not know. It will depend upon the rate of development, an uncertain factor. But schemes have been projected and begun in the Rio Grande Valley within the last eighteen months to take one-half of the ultimate supply of water. Most of these schemes have been projected without any proper consideration of the conditions to be met in order to utilize the greater amount of land. If they are completed and rights finally established on the ground selected, then one-half of the value of the Rio Grande Valley is forever destroyed. The rights and interests thus established will be so wasteful of water that the Rio Grande will sustain only one-half of its possible population. This statement is very conservative. It may be, and it is even probable, that the water

will be able to do only one-third of its duty. And the Rio Grande is a fair illustration of the facts and conditions pertaining to every great river on the arid lands.

This, then, is needed in the Rio Grande Valley, that its agriculture may develop normally and that all rights established may be maintained: In each district the catchment area and the irrigable lands should be determined and defined. To define the irrigable lands it is necessary to measure the waters, in order to discover how much land can be used. Then the irrigable lands should be declared such, and the law should prevent any other lands being irrigated. Then the catchment areas should be defined, and settlement on the catchment areas for agricultural purposes should be prohibited, and the people farming on the irrigable lands should have a right to control the catchment areas and to protect and use the forests and grasses. Then, in each district the storage basins should be segregated and reserved from sale and occupation, so that they may not fall into the hands of speculators, whose rights would have to be purchased before the waters were stored; but the people who live in the district, as a body politic and corporate, should have a right to control these storage basins for the common use. The dam sites and the canal sites ought in like manner to be designated and preserved from sale to individuals and held for the common use of the people. By this plan the irrigable lands would be held in severalty by the people; the sites for reservoirs, canals, and dams, and the catchment areas would be held in common in such district. But in the El Paso district, in which the catchment area is in New Mexico and the Mesilla Valley, and a part of the irrigable lands in New Mexico and a part in the El Paso Valley of Texas and Old Mexico, some means must be provided to divide the waters. It is an interstate and an international problem; but the rights of all of the people now cultivating the soil must be maintained.

To define the districts a topographic survey is necessary; to define the catchment areas and irrigable areas, and to select the reservoir sites, canal sites, and dam sites, a topographic survey is necessary; to divide the waters a hydrographic survey is necessary, and a hydrographic survey is based upon and can be most economically made through the agency of a topographic survey. In selecting the lands in the headwater districts, they should be taken in regions low enough to have a good agricultural climate. In the trunk districts the land should be as near to the points where the waters are taken from the rivers by diverting dams as possible, that these lines may be the shortest and that the least water may be wasted. The reservoir sites, other things being equal, should be selected on the highest lands, where the evaporation is least. As far as possible, reservoirs should be maintained at the least cost and where the danger of destruction is least. The principal lines of canals should all be designated in advance, in order that impedimentary and obstructive rights may not be established. If these things were done in advance of more dense settlement, and then the people permitted to control their affairs in their own way—divide the water among themselves in each district as they please, protect and utilize their forests in obedience to their own judgment, corrected by experience as time goes on, use the pasturage for their flocks and herds, and protect it from destruction that they may thus use it—the arid lands would furnish homes to prosperous, peaceful, and happy people.

The above statement by the Director makes it clear how all the arid lands whose irrigation depends upon the use of the living streams can be divided into natural irrigation districts, so that each body of irrigable land, when properly selected, may have its own catchment area, with a definite and known supply of water on which its people may depend.

SECTION XXIV.

IRRIGABLE LANDS AND CATCHMENT AREAS INTERDEPENDENT.

If the irrigable lands are properly selected they will lie in solid bodies of cultivated fields and gardens, for in this shape they can be cultivated with the least expense and with the least waste of water. About these bodies of irrigable land will stretch pasturage and timber lands on every hand in the hills and mountains. These lands should not become the property of individuals, for they form the catchment areas for the waters needed to serve the irrigable lands, and require special protection for this purpose. The farmers also require the use of the fuel and lumber which the forests will afford, and should protect them from fire for that purpose. The farmers on the irrigable lands can also protect the pasturage and use it to advantage.

It is plain that the people primarily and fundamentally interested in the catchment area are those who cultivate the lands of the irrigable districts, and such people should have control of the catchment area with all its forests and grasses. The farmers are not only interested in the water supply of the catchment area, together with the forests and grasses, but they are also interested in the same area because their principal irrigating works must be constructed thereon. Away from their irrigable lands and on the catchment areas the headworks of canals must be constructed. There also the principal canals themselves must be dug, and there the reservoirs must be situated. In the mountains and on the foot-hills and high in the valleys and on the plains their waters are stored. The chief irrigating works, therefore, for the collection and storage of water, are on the catchment areas outside of the irrigable lands, while only the minor distributing works are on the irrigable lands themselves. It is thus that the real farming on the irrigable lands is largely dependent on the non-irrigable lands of the catchment area, and the farmers must have control of them in the interest of the agriculture which they carry on by irrigation. The best method to protect these in the interest of the farmers themselves is to let them remain as Government reservations for the purposes for which they are needed, and permit the people to protect and use them; and it is believed that these concessions to the districts should be made.

SECTION XXV.

INTERSTATE COMPLICATIONS.

It appears from the exposition that has been made of this matter, that some of these natural districts will embrace portions of two or more States. In most of these cases the catchment areas will be in one State and the irrigable lands in another. From this arises the most serious of complicating conditions, and it appears to make it necessary that the States themselves shall agree to the districting of the country by natural boundaries.

The States that are already organized in the arid lands claim the right to control the waters for irrigation and other beneficial purposes, and they assert this right in their constitutions; and in most cases these constitutions have been accepted by the General Government on the admission of the States from the Territorial condition. But the great body of the lands in these States still belong to the General Government, and these irrigable lands receive their chief value from the waters. The forest lands and pasturage lands almost wholly belong to the General Government, and the irrigable lands are dependent upon them for the water supply. It is thus that the States are alike interested with the United States in the lands and waters, but there seems to be a divided jurisdiction over them. This makes it necessary for the General Government and the State governments to agree on some wise and just policy.

The United States is interested in all of the questions which have heretofore been presented, first, because it is the chief owner of the irrigable lands, the forest lands, and the pasturage lands, and is the custodian of their values, which it seeks to distribute among the greatest number of people who engage in agricultural pursuits; second, because it is the guardian of interstate interests and rights, and must intervene whenever necessary to secure peace and harmony between the States; third, because the General Government is interested in the general welfare of all the people in whatever State or Territory they may abide.

The States are interested in all of these questions; first, because the prosperity of the people of each State largely depends upon the prosperity of the agricultural communities existing therein, agriculture being at the foundation of all industries; second, because each State and Territory is especially interested to protect those persons who are engaged in agriculture by the use of streams which have their catchment areas in other States and Territories; third, because each State is interested in preserving friendly relations with all other States.

The districts are interested in all of these questions because upon their proper solution depends the prosperity of each district—directly as that prosperity arises from successful agriculture, and indirectly as all other industries are more prosperous when agriculture is prosperous.

The individual farmers are all interested, first, in securing permanent and unchallenged rights to the waters necessary to fertilize their farms, that they may thus know the extent of their possessions, and may not be compelled to defend their rights in the courts at great cost, and that they may be relieved of the conflict and litigation which are rapidly springing up in all of the arid region.

It is thus that the United States, the several States and Territories involved, the irrigation districts, and the individual farmers are all in common interested in the solution of the problems which have been presented.

It is believed that the patriotism of the people inhabiting the States and Territories of the arid region will lead them to adopt the plan herein proposed in the interest of peace and harmony between the States, for it is a simple, practicable, and just solution of these interstate conflicts. And they will be more willing to take this action now than hereafter when great interests shall have grown up.

But there are other interests which will impel the States and Territories to acquiesce in the measure. The States that make such concessions of the catchment areas yield lands of small value for agricultural purposes, while the States that receive the benefits acquire water-rights of great value to them on their better lands. Nevada must support its agricultural population in its rich, warm, and salubrious valleys from the waters caught in the mountains of California; but it must yield catchment areas in its own mountains, where the lands are of little value for agriculture, to Idaho and Oregon, where they can be used on good lands. California yields mountainous catchment areas to Nevada, but receives in return the right to use the water of the Colorado River in the southern portion of the State, where several million acres of land will ultimately be redeemed thereby, and these lands will be the most productive in the United States. It will also receive important benefits on the north from Oregon.

There are still other reasons why the States will readily acquiesce, existing in the concessions made by the General Government to the States. By the proposed legislation the forests and the pasturage of each district are given by the United States to such districts. These are vast concessions. Under the bill the great forests of the Sierras will be given to the people of California—distributed among the irrigation districts whose sources of water supply are in those mountains.

It is true that there will be a class of men opposed to this legislation by the General Government who will also oppose the agreement by the States. These are the promoters of irrigation schemes—the great corporations that seek to control the waters and the lands. But the farmers themselves and the great body of the citizens of each State will

not fail to discover the importance of this plan to the welfare of their people, and it can not be doubted that when the matter is fully understood the States will agree to the measure.

SECTION XXVI.

POPULATION OF THE PROVISIONAL IRRIGATION DISTRICTS.

Should all of these great values relating to the use of the water, the use of the forests, and the use of the pasturage be turned over to the people of the natural irrigation districts which have been described, it becomes important to know whether there are a sufficient number of persons to properly take charge of these affairs and to whom these great interests may be intrusted. Director Powell has prepared a series of maps, each one representing a great river basin, on which he has delineated, in a general way, most of the natural irrigation districts which have been heretofore described, and on this subject he has furnished to the members of the committee signing this report the following statement:

A careful study has been made of the arid region of the United States in which irrigation is dependent upon the utilization of the perennial streams, for the purpose of defining the natural irrigation districts in such a manner that every distinct system of irrigation shall be included in one district. A distinct system is composed of a catchment area and the irrigation works necessary to control the water of that catchment area, and the irrigable lands which the controlled waters will serve. In making a preliminary plan of these districts the provisions of the bill introduced by Senator Reagan, which defines how such irrigation districts should be outlined, has been used as the basis by which the districts have been provisionally delineated. It is not possible in the present state of geographic knowledge to outline all of the districts, and it must be understood that the outlines given on the maps presented to the committee and which appear with its report are only provisional. It is probable that a few of the districts will have to be divided; perhaps others can be consolidated. Especially in Montana and the western portion of the Dakotas are there areas where it is yet impossible to draw with confidence the lines of separation. The provisional districts, one hundred and twenty-nine in number, are presented in the following table. They are named in the main from the principal streams, and are arranged in groups by States, and the columns of the table exhibit the class to which each district belongs, as (1) headwater or (2) river trunk or (3) lost stream, the State or Territory in which it lies, and whether in one or more, and the population.

In many of the districts there are cities, and it has not been possible to differentiate the inhabitants of these cities from the agricultural people of the district in which they are situated, though the bill provides that such cities shall not be included in the irrigation districts.

The population is estimated, not by myself, but by officers of the Census Bureau, who are considering this matter for the purpose of arranging the work of enumeration. In order to distribute the work with approximate equality to the Census enumerators, the small districts they are to canvass are outlined with reference to the present distribution of population, and for this purpose a preliminary and detailed estimate of population is made by the supervisors of the Census. The figures of the table are based on this preliminary estimate.

There are one hundred and twenty-nine districts in the arid region. In the same area there are two hundred and thirty-five counties. In the States and Territories involved there are enough people in each county to effect a county organization, and the average district is nearly twice as large as the average county.

Provisional natural irrigation districts of the arid lands.

Name of district.	Class.	State or Territory.	Population.
Upper Arkansas	1	Colorado.....	a 68,500
Lower Arkansas	2	do	5,000
Fountain	1	do	b 20,000
Big Sandy	3	do	5,200
St. Charles	1	do	1,000
Huerfano	1	do	9,000
Apiahapa	1	do	1,000
Purgatoire	1	do	c 15,000
Two Butte	1	do	2,500
Arikaree	1	do	11,000
Lower South Platte	2	do	22,500
Cache la Poudre	1	do	18,300
Big Thompson	1	do	8,000
Boulder	1	do	12,000
Clear Creek	1	do	13,800
Upper South Platte	1	do	d 142,500
Saguache	3	do	4,000
Rio Grande (San Luis Park)	1	do	14,000
Yampa	1	Colorado, Wyoming	8,300
Grand	1	Colorado	33,700
Gunnison	1	do	14,800
White	1	do	2,100
Dolores	1	do	10,200
San Juan	1	Colorado, New Mexico, Utah	15,000
Taos	1	New Mexico	e 7,000
San Ildefonso	2	do	e 10,000
Chama	1	do	e 8,700
Jemez	1	do	e 2,000
Puerco	1	do	e 6,000
Santa Fé	1	do	e 70,000
Albuquerque	2	do	e 25,000
Mealla	2	do	e 15,000
Mimbres	1	do	e 9,400
Salt River	1	Arizona	10,700
Bill Williams	1	do	300
Little Colorado	1	Arizona, New Mexico	14,300
Upper Gila	1	do	34,300
Lower Gila	2	Arizona	8,000
Colorado	2	Utah, Arizona	3,700
San Diego	1	California	g 88,000
Penitas	1	do	1,000
San Luis Rey	1	do	6,000
Los Angeles	1	do	h 100,000
San Bernardino	1	do	48,000
Mojave	3	do	1,000
Santa Clara	1	do	20,000
Santa Barbara	1	do	5,000
Santa Maria	1	do	11,000
Kern River	1	do	17,000
Tulare	1	do	20,000
Kings River	1	do	7,000
Fresno	1	do	20,000
Merced	1	do	21,500
Stanislaus	1	do	13,000
Tuolumne	1	do	12,000
Owens	3	do	3,000
Amargosa	3	Nevada	8,000
Quinn River	3	Nevada, Oregon	1,500
Humboldt	3	Nevada	19,000
Carson	3	Nevada, California	20,000
Truckee	3	do	i 18,000
Walker	3	do	3,000
Lake	3	Oregon	12,000
Des Chutes	1	do	13,000
Malheur	1	do	2,000
Umatilla	1	do	8,000
Grande Ronde	1	Oregon, Washington	15,300
John Day	1	Oregon	10,000
Owyhee	1	Oregon, Idaho, Nevada	3,500
Weiser	1	Idaho	5,800
Payette	1	do	4,500
Boise	1	do	11,000
Salmon	1	do	11,000
Wood	3	do	6,000
Bruneau and Raft River	1	Idaho, Utah	6,000
Lost River	3	Idaho	800
Clearwater	1	do	11,000
Cœur d'Alene	1	do	18,000

a Including Leadville and Pueblo.

b Including Colorado Springs.

c Including Trinidad.

d Including Denver.

e Pueblo Indians included.

f Including Santa Fé.

g Including San Diego.

h Including Los Angeles.

i Including Virginia City.

Provisional natural irrigation districts of the arid lands—Continued.

Name of district.	Class.	State or Territory.	Population.
Snake.....	1	Idaho, Wyoming.....	21, 100
Bear.....	1	Idaho, Utah, Wyoming.....	21, 400
Walla Walla.....	2	Washington.....	20, 000
Crab Creek.....	3	do.....	17, 000
Ogden.....	1	Utah.....	236, 300
Salt Lake.....	1	do.....	588, 200
Tooele.....	3	do.....	6, 000
Sevier.....	3	do.....	22, 300
Price.....	1	do.....	1, 800
Beaver.....	3	do.....	12, 400
Green River.....	2	do.....	1, 100
Fremont.....	1	do.....	1, 000
San Rafael.....	1	do.....	400
Virgen.....	1	Utah, Nevada.....	5, 300
Brown's Park.....	2	Utah, Colorado, Wyoming.....	1, 000
Kanab.....	1	Utah, Arizona.....	1, 700
Marias.....	1	Montana.....	1, 000
Teton.....	1	do.....	500
Sun.....	1	do.....	2, 000
Smith.....	1	do.....	4, 000
Missouri.....	2	do.....	225, 500
Judith.....	1	do.....	3, 000
Deer Lodge.....	1	do.....	449, 000
Jefferson.....	1	do.....	12, 000
Madison.....	1	do.....	1, 400
Gallatin.....	1	do.....	5, 700
Musselshell.....	1	do.....	1, 100
Milk River.....	1	do.....	1, 600
Yellowstone.....	1	Montana, Wyoming.....	8, 000
Big Horn.....	1	do.....	5, 500
Rose Bud.....	1	Montana.....	500
Tongue.....	1	Montana, Wyoming.....	3, 000
Powder.....	1	do.....	5, 500
Clark's Fork.....	1	do.....	e
Knife.....	1	North Dakota.....	1, 000
Heart.....	1	do.....	7, 100
Cannon Ball.....	1	do.....	1, 200
Grand.....	1	do.....	1, 500
Owl.....	1	do.....	1, 500
Little Missouri.....	1	North Dakota, Wyoming.....	1, 100
Cheyenne.....	2	South Dakota.....	3, 000
Belle Fourche.....	1	South Dakota, Wyoming.....	11, 300
South Fork.....	1	do.....	16, 000
Sweetwater.....	1	Wyoming.....	1, 000
Laramie.....	1	do.....	10, 000
Green River.....	1	do.....	9, 000
Black Fork.....	1	do.....	800
North Platte.....	1	Wyoming, Colorado.....	10, 300
Platte River.....	2	Wyoming.....	7, 300
Lodge Pole.....	1	do.....	2, 000
Crow.....	1	do.....	f 11, 000

a Including Ogden.

b Including Salt Lake City.

c Including Helena.

d Including Butte City.

e Unknown.

f Including Cheyenne.

SECTION XXVII.

THE SOLUTION OF THE PROBLEMS.

It is a question of profound importance whether all of these difficulties can be surmounted, whether conflicts can be avoided, whether agriculture in the arid lands can be permanently prosperous, whether the full service of the waters and the largest development of the agricultural industries of the country can be secured, and whether the unearned increment of values can be secured to the farmers. The members of the committee who sign this report believe that there is a simple and effectual way to solve all these problems. The subject of this report is one of great magnitude, for it involves vast interests and pertains to the prosperity of millions of homes now being rapidly established in the arid lands. It is therefore worthy of the most careful consideration of the statesman, for if wise institutions can be established for the

regulation of this new industry in the United States, peace and prosperity will be given to millions of people; but if unwise institutions are developed the people will be plunged into conflict and ruin; the lands and waters of the arid West will be aggregated in the hands of the wealthy few and the farmers themselves will be but hired laborers. The members of the committee signing this report feel that a great responsibility rests upon them, and earnestly invoke from their fellow Senators a careful consideration alike of the problems which have been presented and of the solution of those problems which they now set forth.

The members of the committee signing this report have made a long and careful study of the problems presented in the arid lands affecting the industries of agriculture, and through them all other industries, and they have earnestly sought for some wise and just method by which these problems may be solved. They believe that such a method has been found; that the real solution is simple and obvious, and that the method which they propose will, if adopted, secure prosperity and peace to the farmers of the arid lands. This solution may be briefly set forth in the following manner:

It is proposed to have the entire arid region surveyed into natural irrigation districts in such a manner that each one shall have its catchment area and its body of irrigable lands dependent upon such area. It is then proposed to measure the waters of each catchment area for the purpose of finding how much land can be served in each irrigation district. It is then proposed to select the sites for headworks, canals, and reservoirs by which this water is to be controlled and to plan the irrigation works in the interest of the farmers and to estimate their cost. After ascertaining the amount of water and the amount of land which these waters will serve, it is then proposed to segregate and define the irrigable lands, in sufficient quantity, and no more, for these waters to serve, and to select them in such a manner that the greatest area can be irrigated, and that the best lands, as depending upon climate, soil, and subsoil, may be used, and so that the irrigating works may be constructed with the greatest economy. It is proposed, however, to include in such segregated and designated lands all lands that have heretofore been lawfully irrigated or for which irrigating works have been lawfully constructed.

It is proposed further that the designated waters of the catchment area shall belong to the designated lands of the irrigable area, and that the lands in each catchment area designated as pasturage and timber lands shall not be irrigated. This will fix water rights to lands in such a manner that every farmer will know his rights. It is also proposed to fix the sites of diverting works in river-trunk districts in such a manner as to prevent obstructive and improvident rights therein. In this manner it is also proposed to prevent the development of agricultural industries on lands where such industries can not be permanently maintained. It is also proposed to prevent the enormous waste of waters which is now almost everywhere found, by providing that the waters used shall be measured in quantities of water and not in quantities of land irrigated.

To distribute water values among the farmers and to prevent the creation of permanent water rights dissevered from the lands and in the possession of permanent corporations controlling these rights and perpetually taxing the farmers, it is proposed that the farmers may build their works in any of the following manners: First, by co-operative labor; second, by taxing the irrigated lands; third, through the agency of construction companies to be remunerated by the issuance of irriga-

tion district bonds; and, fourth, through contracts with construction companies to construct the works and deliver the waters for a term of twenty-seven years, at the expiration of which time the works shall be the property of the irrigation districts; and it is proposed to properly guard the making of these contracts.

To administer such provisions it is proposed to constitute each irrigation district a body corporate and politic for specific purposes, and for no other, viz, those relating directly to irrigation and those relating indirectly thereto through the catchment areas where the forests and the pasturage are situated. It is proposed that each irrigation district shall have a board of irrigation commissioners to take charge of all matters relating to irrigation for the district. It is also proposed that each district have an irrigation district court, before which all questions relating to irrigation, the protection and use of the forests, and the protection and use of the grasses shall be submitted for adjudication; and it is also proposed that each irrigation district shall have a superintendent of irrigation with the necessary assistants, a superintendent of forestry and the necessary assistants, and a superintendent of pasturage with the necessary assistants. Equipped in this manner for local self-government relating directly and indirectly to irrigation, the districts will be in a condition to control all of these interests and regulate them by local self-government.

It is then proposed to turn over to the authorities of each district the right and duty to regulate the use of the waters of the district on the irrigable lands, the right and duty to protect and use the forests of the district, and the right and duty to protect and use the pasturage of the district in the interest of the people of the district. It is further proposed that the States and Territories themselves shall provide for organization of these bodies corporate and politic by State or Territorial laws, and that the States or Territories themselves shall provide general statutes controlling the use of waters within the limits prescribed by the United States, and controlling the protection and use of the forests and the protection and use of the pasturage—all under general conditions prescribed by the United States.

Cities and towns are growing up in the arid lands which are centers of mining, manufacturing, commerce, and transportation. These must have water for domestic and other purposes, and it is proposed to permit the States and Territories to designate the waters and the catchment areas which are necessary for these places, and to exclude such waters and catchment areas from the irrigation districts.

As all of these measures require action upon the part of the States and Territories themselves, and as concessions must be made by the States and Territories as well as by the United States to these districts, and as some of the natural districts must be situated in two or more States or Territories, it is proposed to obtain the consent and action of the States and Territories to all of those measures as set forth wherein divided jurisdiction may exist or be claimed; and it is not proposed to make the concessions to the districts and States and Territories until they agree to accept the rights and duties imposed, and also agree to make the necessary concessions to the districts themselves.

SECTION XXVIII.

THE NECESSITY FOR AN IRRIGATION SURVEY.

From the foregoing explanation it will be plain that an irrigation survey should be made by the General Government for the following reasons: First, the irrigation districts must be defined; second, the irri-

gable lands must be defined; third, the sites for irrigating works, as headworks, canals, and reservoirs, must be determined; fourth, the quantity of water in each irrigation district which can be used for irrigation must be determined, in order that the irrigable lands may be reserved in proper quantity, and in order that the works may be planned so as to control these waters; fifth, the works should be planned and the cost of the same determined for the information of the farmers.

The work of the Irrigation Survey, as shown by the Director, is properly divided into three parts: First, the topographic branch of the work, by which the catchment areas, headwork, sites, diverting-canal sites, reservoir sites, delivery-canal sites, and irrigable lands are discovered. Second, the hydrographic branch of the work, by which the streams are gauged to determine the volume of water which can be used for irrigation and which must be controlled in the reservoirs and carried in canals. It has the duty of determining the amount of evaporation from the reservoir sites, so as to discover what loss of water may be sustained through this agency. It also determines the duty of water, or the amount of water necessary to irrigate an acre of land, and it has various other functions relating to the waters. Third, the engineering branch of the work, by which the sites for headworks, the lines of canals, and the reservoir sites are surveyed for the purpose of making plans for such works and determining their probable cost. All of these things the statute directs.

The plan of the Director in organizing the Irrigation Survey, which plan he reported to Congress prior to the act authorizing it, and which plan was adopted by Congress in the act making the first appropriations for the work, appears to be wise, and in all its parts to be necessary to carry out the provisions of the statute. The Director has appeared before the committee and explained the operations of the irrigation work in detail, and he has exhibited many illustrations of the results of the work, and they appear to be of great value, and the survey seems to be conducted with economy.

The survey also seems to be conducted in the interests of the farmers themselves rather than in the interests of water companies. This fact has led to some criticism of the methods and results. In general, the water companies are disappointed because the statute provides for the reservation of the sites for works, including headwork sites, canal sites, and reservoir sites, and prevents their falling into the possession of monopolistic corporations. The statute also provides that the lands which can be irrigated by said works shall be withdrawn from the operations of the desert-land laws, the timber culture laws, and the pre-emption laws, so that they can not be acquired thereunder; but it also provides that these same lands can be acquired as homesteads after proclamation by the President. This provision also seems to be obnoxious to companies and individuals desiring to acquire large tracts of land.

Whether these provisions of the statute are wise or not, the Director of the Survey, as an administrative officer, must be governed by them in the administration of the trust imposed upon him by the statute. Congress is responsible for these laws, including the statute of 1888, and those who believe they are unwise should seek their repeal directly by an appeal to Congress and not indirectly by seeking to annul them in destroying the survey necessary to execute them. Believing that the statute of 1888 is wise and for the interests of the people settling in the arid lands, and generally for the good of country, we earn-

estly recommend the continuation of the survey on the plans already adopted, and further recommend that proper appropriations be made, so that the work may be performed efficiently and vigorously.

If the irrigable lands are segregated and the timber and pasture lands held as national reservations for the benefit of the agricultural and other industries of the country, it will not be necessary to extend the Land Office surveys over any but the irrigable lands. In this manner a great saving may be made, amounting to several times the cost of the Irrigation Survey as it is now conducted. Already great areas have been surveyed into ranges, townships, and sections where such surveys will never be needed. It is probable that the amount wasted in this manner would pay the cost of the irrigation survey.

The Director of the Survey was called on by the Appropriations Committee of the Senate to make an estimate of the cost of the irrigation survey, which he did, and such estimate was published with a report of the committee. In that statement the estimate was made that the total cost would be \$7,000,000, of which amount \$4,000,000 were for the topographic work and \$3,000,000 for the remaining portion of the work; and it was further stated that the \$4,000,000 for the topographic work would have to be expended for that same work for the geological survey, and if made for the irrigation survey the cost of the geological survey would be reduced to that extent. The work of the Irrigation Survey has now been in progress for two years, and the work actually accomplished shows that the estimate was reasonable and that it will cost no more than the estimate.

SECTION XXIX.

THE SURVEY NEEDED FOR THE SUBHUMID REGION OF THE GREAT PLAINS.

The general characteristics of the subhumid region have already been explained in section III. Its water supply is fourfold. There are running through it some large rivers, notably the Missouri, the Platte, the Arkansas, and many minor streams. A portion of the waters of most of these streams can be used in the subhumid region, and can not be utilized elsewhere; another portion will ultimately be cut off and used in the arid region to the west. The supply of stream waters is therefore limited, and will not serve great bodies of land except in North and South Dakota. The chief source of water supply for this region is to be found in the storage of the storm waters, and these waters are to be stored in small tanks or ponds on the several farms irrigated. The survey necessary to their utilization differs from that necessary for the utilization of the stream waters of the arid region. First, it is not necessary to reserve the sites, as they are small tracts scattered among the farms, and in general each man will own his own tank or pond site. Second, it is not necessary to reserve the canal sites, as they will only be small water-ways constructed on the several farms. Third, it is not necessary to segregate and reserve the land; each farmer can designate for himself the lands which will fall under the tank or pond, and which can be irrigated thereby.

The pump-well water will also be of value to the people, as is shown by the experience in agricultural irrigation in other regions of the world. To discover the geological formations which hold such water a geolog-

ical survey is necessary. Finally, there are a few districts where artesian waters have already been found, and other such districts may be discovered, and such waters should be utilized, although their volume is small. But to discover the artesian formation a geological survey is necessary. A geological survey proper must necessarily be based upon a topographic survey. Therefore the present geological survey carries on topographic work, and this necessity is recognized in the statutes, and provisions for such work are made in the appropriation bills.

What the sub-humid region needs, therefore, is a geological survey furnishing a topographic map by which the farmers themselves can plan their small irrigation works, which will consist in the construction of small ponds or tanks on the farms themselves and in the digging of ditches to carry this water to the lands. It also needs a geological survey to point out the rock formations into which pump wells and artesian wells may be sunk. This is provided for by the existing statute, which authorizes a geological survey of the region, and thereby furnishes all of the information which can be given to the farmers who settle in the region.

The operations of the Geological Survey in the sub-humid region of the Great Plains were carried on very slowly until the Irrigation Survey of the arid region for the utilization of perennial streams was created. Thereupon the Director of the Survey withdrew a part of the force of the Geological Survey from the arid region and increased the work of the Geological Survey in the sub-humid region, in order to meet the agricultural wants of the people of that region at the earliest possible date. During the past year the topographic survey of this sub-humid region has been pushed with great vigor in two localities, the one in Kansas and the other in Texas. In Kansas an area of 12,000 square miles has been surveyed and the maps constructed, and in Texas an area of 6,000 square miles has been topographically surveyed and the maps also constructed; and the maps of both of these regions were placed before the committee, and the Director explained how these maps were to be used by the farmers, and how the necessary work was being done in this sub-humid region in the interests of agriculture. It is very important that this work should be completed at an early date. The region of country has already been settled from time to time, but the settlers have met with disaster, not recognizing the fact that irrigation is necessary for permanent prosperity. Before these regions are resettled, all of the facts should be known. It is therefore recommended that larger appropriations be made for work in this special region, so that relief may be given at the earliest possible day to these suffering farmers, and that future settlers may be informed of the conditions necessary to success and prosperity. No additional draft on the treasury will be needed for this, as the geological survey is already authorized by law and will be done in course of time. The appropriations should be increased and the length of time for the work shortened.

SECTION XXX.

LEGISLATION RECOMMENDED.

To accomplish these purposes a bill was introduced by Senator Reagan and referred to the Select Committee on the Irrigation and Reclamation of Arid Lands. It is numbered 2837. On a more careful consideration of this bill it is believed that it should be amended, and

it will be given at the end of this report in its amended form, and its passage is recommended. The new bill is numbered 3769.

The purpose of the bill is to provide by legislation that all of the public domain which is valuable for agricultural purposes may be distributed among actual settlers who will themselves engage in farming. That these gifts of homesteads to the people may have their greatest possible value, it is proposed that the rights to use the waters of the arid lands shall be attached to these homestead lands and to none others. To make the homesteads of still greater value it is proposed to give to the farmers on the irrigable lands the right to use the forests, that they may protect them from fire and preserve the sources of water supply. It is also proposed to give these same farmers the right to use the pasturage of the grass lands. It is then proposed to turn over the whole subject of irrigation to the farmers themselves that they may construct the irrigating works or cause them to be constructed, and regulate the division of the waters on the irrigable lands in their own way. It is proposed that the General Government shall never be called upon to construct the works of irrigation, and that surveys only shall be made at the charge of the general Treasury.

SECTION XXXI.

ANALYSIS OF THE BILL.

In explanation of the bill the following statements are made:

Section 1 of the bill provides for a survey of the arid lands and their segregation into irrigation districts of three classes, viz, districts of the first class, or head-water districts; districts of the second class, or river-trunk districts; and districts of the third class, or lost-stream districts. It provides also that the boundaries of the districts shall be marked upon the ground, and that topographic maps shall be constructed, and that this work shall be done by the United States Irrigation Survey, which is an integral part of the Geological Survey.

Section 2 of the bill provides for the selection of the irrigable lands in each district, such selections to be governed by the following conditions, to wit: First, the conditions necessary to secure the greatest area of irrigable lands. Second, the conditions necessary to secure for agricultural purposes the most valuable lands by reason of climate. Third, the conditions necessary to secure the most valuable agricultural lands as determined by soil and subsoil. Fourth, the conditions necessary to secure lands that can be irrigated and cultivated with the greatest economy.

Section 3 of the bill provides that lands already irrigated, or for which irrigation works had been constructed prior to the passage of the act of October 2, 1888, providing for the segregation of irrigable lands, shall be declared and deemed irrigable lands for the purposes contemplated in the bill. This provision is necessary to protect existing rights.

Section 4 of the bill provides that the works constructed in irrigation districts of the second class, or river trunk districts, must occupy the sites designated by the Irrigation Survey, for the purpose of protecting the water rights of the several irrigation districts, and to prevent the construction of improvident or obstructive works; and it makes it unlawful to construct any other works in such districts. The wisdom of this has been explained as being necessary to prevent conflict between irrigation districts and waste of water.

Section 5 of the bill provides for a division of the waters between irrigation districts by assigning to each the waters of a designated catchment area, and prohibits the use of waters for irrigation on any lands but designated irrigable lands and town-site lands.

Section 6 of the bill provides that whenever any irrigation district, as planned by the United States Survey, shall fall within the domain of two or more States or Territories, the people occupying and cultivating the irrigable lands shall have a right to construct works of irrigation and maintain the same, although they may be situated in another State, and shall have a right to protect and use the forests and the pasturage in the interest of the cultivated lands; and that the right to use such sites, works, forests, and pasturage shall not be obstructed, and that it shall be unlawful to levy any tax on such waters, forests, and pasturage by the State or Territory wherein they are situate; provided that such States give their consent.

Section 7 of the bill provides that all of the lands belonging to the United States in any irrigation district shall remain the property of the United States, except the mining lands, which may be acquired by individuals under the statutes providing for the acquirement of such mining lands, and except the coal lands, which may be acquired by individuals under the statutes of the United States providing for the acquirement of such coal lands, and except such town-site lands as may be selected by the proper persons under the statutes of the United States providing for the acquirement of town sites. It also provides that the irrigable lands may be acquired by individuals through the agency of homestead settlement, as regulated by the United States statutes, in tracts not greater than 80 acres; and, finally, it gives to the farmers of each irrigation district the right to control the waters for irrigation purposes, the right to control the catchment areas for irrigation purposes, and the right to use and protect the forests and the pasturage on the public domain within the district.

Section 8 of the bill provides that every settler on a homestead tract shall have the right to use his proportional part of the water of the irrigation district in which his farm is situate, and shall have the right to use this water when controlled by the irrigating works, by paying his proportional share of the cost of such works; but it leaves it with the State or the districts to determine what this proportional share is, and how and when it shall be paid. This section is necessary to prevent the establishment of local laws that might prohibit settlement on the irrigable lands.

Section 9 of the bill makes it unlawful for any person or corporation to construct irrigation works in any of the districts, except such as are properly authorized.

Section 10 of the bill provides, in general terms, a method by which the irrigation districts may be organized, and requires such districts to provide a board of irrigation commissioners, who shall have general control of irrigation within the district; and to provide for an irrigation court to adjudicate questions relating to irrigation, the protection and use of the forests, and the use and protection of the pasturage. It also provides for a superintendent of irrigation in each district and the necessary assistants, for a superintendent of forestry and the necessary assistants, and for a superintendent of pasturage and the necessary assistants.

Section 11 of the bill provides that it shall be lawful for the commissioners of each irrigation district to provide laws and rules for the use

of the waters belonging to the district on the designated irrigable lands, for the use and protection of the forests, and for the use and protection of the pasturage.

Section 12 of the bill provides that it shall be lawful for the States and Territories in which the irrigation districts are situate to provide, by general statutes, for the use of the water in the irrigation districts on the irrigable lands, and for other useful and beneficial purposes. It also authorizes the States and Territories to provide statutes to regulate the construction of irrigating works, under authority of the commissioners of the several irrigation districts, by any of the methods, to wit: First, by the co-operation of the people interested therein; second, by taxes levied on the lands irrigated; third, by the issuance of irrigation district bonds, the interest and principal to be paid by taxes levied on the lands irrigated; fourth, by granting to persons or corporations the right and imposing on them the duty of supplying water for irrigation and other beneficial purposes, through the agency of irrigation works, for a term of twenty-seven years, and by providing that the services of such persons and corporations shall be paid for by the users of the water at just and reasonable rates for measured quantities of water, and not at rates per acre or quantity of land irrigated, and, by further providing that at the expiration of twenty-seven years from the beginning of the first service of water the rights and duties of such persons or corporations shall terminate, and all such irrigation works shall thereupon become and be the property of the irrigation districts to which they pertain. The States and Territories are also authorized to pass general statutes relating to the protection and use of the forests, and the protection and use of the pasturage—all to be in conformity with United States statutes.

Section 13 of the bill provides that it shall be lawful for any State or Territory in which irrigation districts are situate, to provide for the organization of a State or Territorial board of irrigation commissioners to supervise and approve all contracts made by the irrigation district commissioners for the construction and maintenance of irrigation works.

Section 14 of the bill makes it lawful for any State or Territory to define the boundaries of any city and to designate the waters to be used in such city for domestic, horticultural, and other purposes, and to exclude such cities and such waters from the irrigation districts.

Finally, section 15 of the bill provides for the consent of the States and Territories interested to this legislation, and refuses the rights and benefits to any State or Territory which fails to give its consent.

SECTION XXXII.

REMARKS ON THE BILL.

It will be noticed that the plan formulated in the bill calls on the General Government for no expenditure but that necessary to complete the surveys; that the whole cost of construction and maintenance of irrigation works is placed upon the several irrigation districts and there placed upon the lands irrigated. It also provides that water rights and land rights shall never be dissevered, and that the irrigation works shall from the first, or after a term of years, be the property of the farmers themselves who are the owners of the land. It also places in the hands of the people directly interested in the matter, namely, the farmers on the irrigable lands, the right to use the forests and the right to pro-

tect them from spoliation; and the pasturage lands are also turned over to the districts to be utilized in such manner as they may select. The bill provides all possible safeguards against the aggregation of lands in the hands of individuals and corporations, against the aggregation of water rights by companies, and against improvident contracts with companies for the construction of irrigation works. Finally, it provides a form of government for these districts, with legislative, executive, and judicial functions in harmony with the institutions of the country.

The bill asks and requires the consent of the States and makes it to their interest to give such consent; therefore the plan of the bill can meet with no objection from the most ardent adherent to States rights. And on the other hand it is believed that it will be satisfactory to those who believe in the paramount authority of the General Government.

There are minor provisions in the bill which perhaps are not absolutely essential parts, but which it is believed are important and obviously wise.

It will thus be seen that the plan proposes to relegate the whole subject of irrigation to districts, to be regulated and controlled by local self-government, and proposes that the General Government shall interfere in the matter to the least possible extent. It provides that all of the many complex problems which grow out of this new industry shall be solved by the people who are themselves directly interested, and it takes the precaution to turn over the question to such interested people and to no others. It obviates the necessity for any legislative, administrative, or judicial interference with the subject of irrigation by the General Government, but it does prescribe the district boundaries and it divides the waters among the districts and it segregates the irrigable from the non-irrigable lands. The General Government can not do less than this and do its duty to the people of the arid lands. It can not permit the public domain to be wasted through the acquirement of improvident and obstructive water-rights. It must interfere to prevent neighboring States from being plunged into conflict disastrous to the harmony of the country, and it is in duty bound to devise some means to provide for the protection of the forests and pasturage lands which are now being laid waste. It is believed that all these purposes will be accomplished by the bill if it becomes a law, and that it will insure prosperity and peace to the energetic and patriotic people who are settling on these western lands.

SECTION XXXIII.

THE METHOD OF DISPOSING OF THE WATER-RIGHTS AND THE LANDS OF THE ARID REGION IN THE BILL REPORTED BY THE MAJORITY IS NOT APPROVED.

The majority of the committee have reported and recommended for passage another bill, entitled "A bill to provide for the conservation and use of natural water supplies upon certain portions of the public lands of the United States, and for other purposes," and which is numbered 2104. The members of the committee signing this report dissent from the conclusions of the majority as to the propriety of passing the bill, and deem it their duty to present the reasons causing them to disagree with the majority. The objections to this bill are as follows:

(1) It seems to us to be in the interest of the great cattle companies that pasture their animals on the public domain, and opposed to the interests of the farmers who are making homesteads on the lands.

(2) It also appears to be in the interest of the great irrigation companies rapidly developing in the West, who seek to gain control of the land and the waters alike, and it practically excludes from ownership the poor man who settles upon the land for the purpose of obtaining a home.

Such a result is believed not to be in the interest of the great body of people settling in the country. To show that these conclusions are correct, the bill will be analyzed and its effects pointed out.

Section 1 declares "all natural waters not now otherwise appropriated found upon and within the public lands of the United States lying west of the ninety-eight meridian of longitude west from Greenwich" to be public property, "inalienable from and forever attached to the land for such beneficial uses as the States and Territories in which such waters are situated shall determine." It then goes on to declare that, "subject only to the paramount sovereignty of the United States for such beneficial uses," such waters "shall be placed under the authority of the State or Territory wherein said natural waters flow or are found, whether the same be running streams, lakes, pools, ponds, springs, or other surface bodies of water, or subterranean streams, pools, or underflows, produced by natural seepage and drainage within the areas affected by this act."

If the purpose of this section is to give the States power to control the waters to be used for irrigation within the States, it is unnecessary, as the States already possess and exercise that power. Most of the States of the arid region affirm their right to exercise this power in their constitutions, and most of these constitutions have been accepted and approved by the United States in admitting such States into the Union from the Territorial condition. But it appears that the real effect of this section is to assert the paramount sovereignty of the United States over the use of such waters for beneficial purposes. The clause is manifestly to be thus interpreted. The effect of the clause is made more apparent by an examination of the third section, which is as follows:

SEC. 3. That access to natural waters within the section west of the ninety-eighth meridian aforesaid, which may be necessary to the direct support of man or *domestic animals*, shall never be denied, but such access to natural waters shall be and remain a permanent right of way, subject to rule and regulation by the State or Territory for such right of way, and for the prevention of trespass, unlawful occupancy, or spoliation in any way.

It appears that the effect of this section is to secure to the nomadic cattle and sheep companies the privilege of using the pasturage on the public lands, by securing to them rights of way to all watering places, "whether the same be running streams, lakes, pools, springs, or other surface bodies of water, or subterranean streams, pools, or underflows, produced by natural seepage and drainage within the areas affected by this act," in defiance of the authority of the States. The first section of the bill, which is declaratory, paves the way to this construction. The interests which this bill thus attempts to foster are opposed to the interests of the great body of farmers who are settling upon the lands. The ranching interests are largely in the hands of great companies operating with foreign capital. In general the owners and employes of these companies which infest the public domain drive their great herds of cattle and flocks of sheep over the land and destroy the pasturage and burn the forests. The flocks of sheep that roam over the mountains of California are destroying the grasses of the great sierra, and irresponsible

herders are destroying the finest forests in the world with the fires which they wantonly kindle. To such interests is the bill under consideration dedicated.

Section 5 practically repeals the desert-land laws, the timber-culture laws, and the pre-emption laws, and to the wisdom of this we assent. The bill leaves the homestead laws unmodified, except as follows: It gives to the Commissioner of Irrigation—the incumbent of an office created by the bill—the power to determine from time to time the area of the homestead tract. This appears to us to be a dangerous power to give to one man.

The bill then provides for two classes of irrigation districts. In one class the territory to be included in each district is to be selected and defined by the water company. In the other class the territory to be selected and defined in each case is left to a community already existing, and it provides the means by which the area already irrigated may be increased and new homesteads acquired by settlers in such districts. The water company districts are to be organized under the provisions of the following clause in section 5:

Whenever the proper authorities of any State or Territory shall present a survey and map to the Commissioner of Irrigation giving the boundaries of the irrigable land in a district which can be irrigated by one system, together with the reservoirs, lines of ditches, and other hydraulic works, and represent to said commissioner that the hydraulic works, including reservoirs, canals, and other improvements, which are for the common benefit of all the irrigable lands in such district, have been constructed and completed in a substantial manner and approved by the State or Territorial authorities, it shall be the duty of said commissioner to cause an examination to be made of such district and the hydraulic works constructed for the irrigation of the same, and if such hydraulic works shall be ascertained by him to be well and substantially constructed and suitable for the irrigation of the irrigable lands in such district, he shall approve the same and transmit to the Commissioner of the General Land Office a certified copy of such survey and map; whereupon the persons who have made lawful claims to any of such irrigable lands shall be allowed to prove up their claims and receive patents therefor: *Provided*, That the applicants for such lands shall have performed the acts required by the law under which the claims were made, but as to desert land claims heretofore made no further proof shall be required as to the desert character of the land or reclamation of the same.

Under this part of the section an irrigation company can construct the necessary head-works on any stream and divert the waters to a tract of unoccupied lands, and the members of the company and other favored and selected persons can file claims to these lands, and when the works are constructed all of these persons can get titles to their lands, but can not irrigate them except by the permission of the company owning the works. Thereupon the company may sell water-rights to the owners of these lands, who mortgage their farms to the company for amounts they can often never pay, and in the end the company will usually become the owner of both waters and lands. The settlers on the public lands will be wholly at the mercy of the water companies.

It will be noticed further that the proposed Irrigation Commissioner is given no authority to disapprove of such works except on the sole ground that they are improperly constructed. He is given no authority to determine whether they are in conflict with rights already established by communities or other companies; is not authorized to examine into the question of the volume of water supply which the works will command, to see whether the lands under the works can be actually irrigated or not. But if good works are constructed he must approve them whether the people on the lands irrigate them or not. To people who have not carefully studied the subject by observation and experi-

ence, a stream appears to furnish an almost boundless supply of water. But for irrigation large quantities are needed. On the average in the United States an acre of water a foot deep is needed every year to irrigate an acre of land—10,000 acre-feet to irrigate 10,000 acres of land; and the settlers actually going into the country do not properly understand this, nor do they know how to measure running waters to discover how much they will supply. Experience shows that by reason of this want of knowledge of the quantitative facts, irrigation works are often multiplied upon a stream beyond the necessity to control its waters. The cost of construction is incurred, but the water is insufficient to supply the lands which ought to bear it, and the lands which are actually redeemed are thus made to bear an inordinate expense.

That the effect would be to place the greater part of the irrigable lands of the arid region that are to be watered by streams under such companies is made very plain by the facts which have heretofore been presented in the statements made about the great numbers of irrigation companies already organized for this purpose under State and Territorial charters. But for the law of 1888, reserving sites and lands, almost all of the water rights would now be in the possession of such companies. In fact, in many regions these inchoate and speculative water rights are already far in excess of the water supply, and the effect of this clause of the bill which we are now considering is to confirm all of these charters and speculative rights, and to remove any obstruction to the aggregation of water rights in the hands of a comparatively few companies, most of which are organized on the basis of foreign capital and whose interests are in direct conflict with the interests of the settlers already in the country who are engaged in farming. Nearly every stream the seasonal flow of which is not fully used can be taken onto such districts, and all the water to be stored in reservoirs can be used in this manner; and in the main the companies are already organized to do it, and but await the hoped for action of Congress by which the legislation of 1888 shall be annulled. If the sites now reserved are turned over to the control of the States and Territories, these States and Territories have already disposed of them to companies, and that result is effected by the bill.

That this is the real purpose and effect of the bill is made plain in the report of the majority, in which they state that they will move the following amendment to the bill:

That so much of the act of October 2, 1888, entitled "An act making appropriations for the sundry civil expenses of the Government for the fiscal year ending June 30, 1889, and for other purposes," as reserves "all the lands made susceptible of irrigation by the reservoirs, ditches, or canals," mentioned in said act, is hereby repealed; so that the reservation in said act shall only include all the land which may, after the passage of said act, have been or may hereafter be designated or selected by United States surveys for sites for reservoirs, ditches, or canals for irrigation purposes. And bona fide claims, made since the passage of said act, to land within the reservation hereby repealed shall not be defeated or affected by said act: *Provided*, That the diversion of water at high altitudes, where all the agricultural crops produced in the same latitude in the valleys below do not mature, shall confer no prior rights to the use of such water as against persons below who appropriate the water to irrigate land more suitable for homestead settlement, unless such diversion shall be approved by the Commissioner of Irrigation.

It has already been shown in Sections XVIII and XXI that speculative rights and charters to nearly all the stream waters of the arid region have been acquired by squatter title and official State filings and charters in defiance of the statute of October 2, 1888, and since that time, and by this amendment it is proposed to directly confirm all of these speculative and charter rights, and to put into the hands of a com-

paratively few corporations all of the unused waters of the arid region.

It must be further explained that this provision could be used by the settlers themselves, who might go upon the unoccupied lands as colonies and organize themselves into companies to construct the irrigation works had they the capital necessary for the purpose. The provision might thus serve a valuable purpose had not the companies already prevented it by obtaining inchoate charters and rights under local laws. But promoters, tempted by the prospect of large remuneration, have already in most cases, and would in all others, seize upon the waters, and thus the agriculture of more than two-fifths of the area of the United States would fall into the control of such companies.

But there are still small tracts of land situated in neighborhoods where irrigation has already been developed, and provision is made for the settlement of these tracts and their redemption by irrigation in the sixth section of the bill, which is as follows:

SEC. 6. That whenever, under the authority of any State or Territory, an irrigation district shall have been organized and the qualified electors thereof empowered to levy taxes, charges, or assessments upon public and private lands situated in such district for the purpose of constructing hydraulic works for the common benefit of the irrigable lands therein, the irrigable lands of the United States in such district shall be subject to the same taxes, charges, and assessments as are so imposed upon other public lands and land belonging to private individuals; and persons who shall thereafter acquire title to lands from the United States in such district shall take the same subject to the said taxes, charges, and assessments, which shall be a lien upon such land, the payment of which may be enforced after such title is acquired from the United States in such manner as shall be prescribed by the State or Territory in which such district is situated: *Provided, however,* That before such taxes, charges, and assessments shall be chargeable against the public lands of the United States, or be a lien thereon, the rate and amount thereof shall be approved by the commissioner of irrigation of the United States: *And provided further,* That the United States shall not be liable for such taxes, charges, or assessments.

This section provides for the expansion of the area of irrigation in districts already settled by giving the people who live in such districts the right to construct works and to charge a portion of the cost to the unoccupied lands of the public domain, and making such charges a lien upon the lands inoperative as long as they are held by the General Government, but immediately operative when they pass into the hands of individuals. The settler entering upon such a tract of land could not make the homestead without using the water, and he could not get the water onto his land until he had extinguished the mortgage for a sum including the share of the original cost of the works and the accumulated taxes. If this would not prevent the settlement of such lands it would at least prevent their settlement by poor men. Men of wealth might acquire titles to such lands, but they would usually be unwilling to make bona fide homesteads thereon, and their compliance with the provisions of the homestead act would necessarily be but nominal.

Section 7 provides that irrigation districts may be organized in two or more States and Territories by the agreement and consent of the States and Territories involved, and it further provides, that if any State or Territory does not assent to and approve the organization of such irrigation district the people may still proceed with their organization under the authority of the State or Territory in which the principal body of irrigable lands are situated, but it does not protect the district from unfriendly legislation and the obstructive acts of the dissenting State or Territory, nor does it seem probable that the General Government has the constitutional right to provide such protection.

It may be noticed that the irrigation districts provided for in this bill are not the natural districts for which the bill recommended by the

minority provides. Under the bill recommended by the majority, two classes of districts are provided with artificial boundaries. The one includes tracts of land and sites for works where such sites and lands are not already occupied, and the bill virtually puts these under the control of water companies. The second class of districts which it provides relates to regions where settlement is already made and where irrigation is already practiced; and provides that any such district may grow by new settlement on the lands which are mortgaged for works and taxes, and practically excludes poor men from such homestead lands.

SECTION XXXIV.

THE CREATION OF A NEW BUREAU OF IRRIGATION IN THE AGRICULTURAL DEPARTMENT UNNECESSARY AND UNWISE.

Section 8 of the majority bill provides for the organization of a new bureau in the Agricultural Department, at the head of which shall be an officer styled the Commissioner of Irrigation. It also provides for a chief clerk, and for "a sufficient number of engineers, clerks, and other employes to execute such laws relating to irrigation, as have been or may hereafter be passed by Congress, and to perform such duties as shall be prescribed by the Secretary of Agriculture." It seems not to create a new irrigation survey, but only a new bureau, with officers sufficient to determine the proper size of the homestead tract from time to time, to examine and approve or disapprove of certain "taxes, charges, and assessments" against the public lands, and with engineers sufficient to examine the works after they have been constructed by irrigation companies and approve or disapprove of them. But it provides further that "all surveys, maps, and reports relating to irrigation, of record or on file in any department of the Government, shall be transferred without delay to the Secretary of Agriculture." It thus appears to contemplate the discontinuance of the present irrigation survey, though it does not provide for it by repealing its organic act. The purpose of the bill in this respect seems to have been more clearly set forth in the report submitted by the chairman of the committee.

The report presented by the majority recommends that the topographic work be discontinued and that the hydrographic work be given to the Signal Service; but it is silent on the subject of the engineering work. It is perhaps the effect of the bill and the report to discontinue the irrigation survey, and in lieu thereof to create a new bureau to determine from time to time the size of the homestead tract, to examine and approve or disapprove of certain "taxes, charges, and assessments" against the public lands, to examine and approve or disapprove of works, and "to execute such laws relating to irrigation as have been or may be hereafter passed by Congress."

The signers of this report believe that the present irrigation survey should be continued, that the work which it is performing is necessary and useful, and that it is doing the work in the most economic manner consistent with the proper conduct of the work and the accomplishment of valuable results. They therefore recommend its continuation, and urge the importance of making the necessary appropriations to complete the survey without great delay.

An artesian-well survey is recommended, and it seems to be the purpose to place this under the direction of the proposed bureau of irrigation. But an artesian-well survey is in all essential particulars, if properly conducted, a geological survey. Two geological surveys would seem to be unnecessary, a multiplication of organizations for the same

function, which would involve increased expense, and rival geological surveys would thus be created. It is probable that the next step undertaken would be to destroy the present organization.

The effect of the bill reported by the majority is not plain in relation to the survey, but in the light of the report it seems probable that the purpose is to connect with the bureau of irrigation a survey to select sites and make plans for works, and an artesian survey to make investigation in relation to subterranean waters, and to do the work in part by a geological survey and in part by the experimental boring of wells. It is also proposed in the report, but not in the bill, to make a hydrographic survey through the agency of the Signal Service. Thus the work is to be divided among three organizations: The topographic survey, under the Geological Survey; the irrigation survey, under the bureau of irrigation, by faulty and enormously expensive methods for the discovery of sites through the agency of trial lines; and the hydrographic survey, under the Signal Service. Under this provision the irrigation survey would in part be a duplicate of the present Geological Survey. Such is the mixed system of administration which the bill and the report together provide. It is believed that the work done in this manner would be inefficient and greatly expensive.

SECTION XXXV.

THE DIRECTOR OF THE SURVEY HAS NOT MISAPPLIED THE APPROPRIATIONS MADE FOR THE IRRIGATION SURVEY.

The following statement, made in the report of the majority is incorrect and unjust:

Subsequently the whole subject was turned over to the Director of the Geological Survey with general provisions for the classification of the public lands, he having previously prepared a valuable report on the arid lands of the United States. The most important action by the Government in aid of the reclamation of desert lands was the passage of the acts of October 2, 1883, and of March 2, 1889. By the first of these acts \$199,000 was appropriated for topographic surveys, and \$100,000 for surveys pertaining to irrigation. Of the sum appropriated for irrigation \$60,000 was diverted by the Director from that purpose and added to the appropriation for topographic surveys, making the sum of \$259,000 for topography and leaving only \$40,000 for irrigation.

By the act of March 2, 1889, \$200,000 was appropriated for topographic surveys, and \$250,000 for irrigation surveys. Of the sum appropriated for irrigation surveys \$120,000 was diverted from that purpose by the Director and added to the \$200,000 for topographic surveys, making the aggregate of \$320,000 for topography, and leaving only \$130,000 for irrigation surveys and the office and other expenses incidental thereto. Your committee regard this as a plain violation of the statute and a misapplication of the money.

The provision of law authorizing this last appropriation sets forth in some detail the purposes to which it is to be applied, etc. Among those purposes it mentions "the necessary maps." The Director of the Survey has construed the words "necessary maps" to mean topographic maps of the same kind as those that are provided for specifically in the first item of \$200,000, and he has applied more than half the irrigation item to that purpose, leaving less than half of the \$250,000 for the objects for which it was intended.

It is thus by implication made to appear that the topographic survey for which \$199,000 was appropriated on October 2, 1888, and for which \$200,000 was appropriated on March 2, 1889, was for the irrigation survey, when in fact, as the act itself shows, these items were designed to be used in making maps for the Geological Survey. The topographic survey made under the appropriation for the irrigation survey was a part and parcel of such irrigation survey, made in the interest of the irrigation survey, and by distinct authority of law. Prior to the cre-

ation of the irrigation survey the Geological Survey had been in progress many years, and was making topographic maps in various States and Territories, being authorized to make such maps for geological purposes. The regions where this work was in progress were scattered about the country from the Atlantic to the Pacific, and as it was a geological survey, mining regions were selected for the theater of operations.

When the Irrigation Survey was created by act of Congress, it was not proposed to interfere with or change in any manner the operations of the Geological Survey and the topographic work connected therewith. The work went on in the usual manner, unaffected by the statute creating the irrigation survey. The topographic work still went on in Maine, in Texas, and elsewhere throughout the country. One hundred and ninety-nine thousand dollars was appropriated by the act of October 2, 1888, for these topographic surveys forming a part of the Geological Survey, and \$200,000 in the following year, and the work went on as usual thereunder. By some singular oversight, which a glance at the act would have at once corrected, the majority of the committee have concluded that this appropriation was made for topographic surveys connected with the irrigation survey—a mistake which it is impossible to explain. In the same act, viz, the sundry civil appropriation act, there was another paragraph making an appropriation for the work of the irrigation survey of \$100,000 in the following words:

For the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation, and the segregation of the irrigable lands in such arid region, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and the prevention of floods and overflows, and to make the necessary maps, including the pay of employees in field and in office, the cost of all instruments, apparatus, and materials, and all other necessary expenses connected therewith, the work to be performed by the Geological Survey, under the direction of the Secretary of the Interior, the sum of one hundred thousand dollars or so much thereof as may be necessary. And the Director of the Geological Survey, under the supervision of the Secretary of the Interior shall make a report to Congress on the first Monday in December of each year, showing in detail how the said money has been expended, the amount used for actual survey and engineer work in the field in locating sites for reservoirs and an itemized account of the expenditures under this appropriation. And all the lands which may hereafter be designated or selected by such United States surveys for sites for reservoirs, ditches or canals for irrigation purposes and all the lands made susceptible of irrigation by such reservoirs, ditches or canals, are from this time henceforth hereby reserved from sale as the property of the United States, and shall not be subject after the passage of this act, to entry, settlement or occupation until further provided by law:

Provided, That the President may at any time in his discretion by proclamation open any portion or all of the lands reserved by this provision to settlement under the homestead laws.

When the first appropriation for the irrigation survey was made, the sum was \$100,000, and it is charged that of this amount more than one-half has been misapplied by the Director, a charge so baseless that it is difficult to understand how it could be made with sincerity. The appropriation was made to do a number of specified things, and this is one of them "to make the necessary maps." To make maps a topographic survey is necessary—topographic surveying is map-making. That this is the correct construction of the law is made plain by the history of its enactment. The irrigation survey was created by an act approved March 20, 1888. On March 27, just seven days after, the following resolution passed the Senate:

Resolved, That the Secretary of the Interior is hereby directed to report to the Senate what appropriation is necessary to enable the United States Geological Survey to carry into effect the joint resolution "directing the Secretary of the Interior by means of the Geological Survey to investigate the practicability of constructing reservoirs for the storage of water in the arid region of the United States and to re-

port to Congress," approved March 20, 1883, and the several acts of Congress requiring such Geological Survey, under the direction of the Secretary of the Interior, to classify the public lands and furnish a map or maps showing the various divisions of the public domain suitable for agricultural, mineral, and other purposes; and particularly to segregate the lands susceptible of irrigation where irrigation is required from other lands, and designating places for reservoirs, canals, and other hydraulic works.

By this resolution the Secretary was directed to make estimates for the irrigation survey which should include estimates for "a map or maps." In reply thereto the Secretary transmitted a letter from the Director of the Geological Survey, making such estimates and submitting a plan for the survey. From the plan the following quotation is made:

To determine for a given stream, or for a given group of streams treated collectively, first, the maximum area of farming land and its most advantageous selection; second, the best selection of sites for reservoirs and their proper size; and third, the best system of head-works and canals, there are three general requisites, as follows:

(a) The construction of an accurate topographic map, with grade curves at such intervals as will properly represent the configuration of the ground.

(b) The determination of the total annual discharge of water from the catchment basin, or where there are more than one, from each catchment basin, and the distribution through the year of that discharge.

(c) An examination of the soils in the area from which, under existing topographic conditions, the selections of lands for irrigation must be made.

This document, which outlines the plan for an irrigation survey, is worthy of an examination. A full and plain statement is made therein of how an irrigation survey should be conducted, and after setting forth the matter fully, the Director closes with the following:

Impelled by these considerations, I respectfully recommend that an appropriation of \$250,000 be made for the first year's work, and would suggest the following clause for the appropriation bill:

For the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation, and the segregation of the irrigable lands in such arid region, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation, and to make the necessary maps, including the pay of employes in field and in office, the cost of all instruments, apparatus, and materials, and all other necessary expenses connected therewith, the work to be performed by the Geological Survey, under the direction of the Secretary of the Interior, the sum of two hundred and fifty thousand dollars.

It will thus be seen that having explicitly stated that a topographic survey would be necessary, he made estimates for its prosecution in these words: "and to make the necessary maps." It will also be observed that the entire paragraph submitted by the director was incorporated in the statute after he had explicitly and fully explained its purpose, and after his statement had been submitted to the Senate and printed as a public document and referred to the Appropriations Committee.

This would seem to furnish a thorough vindication of the action of the Director of the Survey. He had fully explained that a topographic survey was a necessary part of an irrigation survey; he suggested a clause for the appropriation act which should authorize and direct him to make that topographic survey as a part of the irrigation survey, and the suggested clause was incorporated into the statute.

But the history of this matter does not end here. The Appropriations Committee of the Senate summoned the Director of the Survey to appear before it to explain his estimates, and an explanation was made of this particular thing in language singularly plain and simple, and the statement of the Director of the Survey was published by Congress as a part of the report of the Appropriations Committee as an explanation made by that committee of its reason for recommending the

appropriation. The Director explained that he was already making a topographic map of the entire country in obedience to the provisions of the law, and that ultimately, after many years at the rate of progress then made, it would be finished, and that an irrigation survey could thereafter be made at a small expense; but if it was necessary to make the irrigation survey at once, it would be necessary to make a topographic survey in connection with it.

The following quotations are made from the report submitted by Mr. Allison from the Committee on Appropriations, Fiftieth Congress, first session, Report 1814, to accompany bill H. R. 10540.)

By the CHAIRMAN :

Q. Are you through with your general statement?—A. Yes, sir; but I want to speak something about the cost.

Q. That is what we want to hear you upon.—A. To complete the survey as we have been going on, without laying out the reservoirs, without laying out the sites for head-works and canals and so on, would take about \$5,000,000. We have expended about \$1,000,000, so that it would now take about \$4,000,000 to complete that work.

By Mr. BECK :

Q. And what length of time?—A. At the rate we have been going on it would take between thirty and forty years.

Q. With ample means how long would it take?—A. It could be done in ten years.

Mr. STEWART. Is it necessary to wait until you work up all the geological data in order to make the preliminary survey with a view to reservoirs?

Mr. POWELL. No, sir.

Mr. STEWART. That only refers to the local topography?

Mr. POWELL. To the construction of the maps.

The CHAIRMAN. Major Powell is speaking only of the topographical survey.

Mr. STEWART. No, of the geological.

Mr. POWELL. Not of the geological, but the topographical survey which we are conducting over the country.

Mr. STEWART. Can you not vary your survey so that these reservoirs can be located more rapidly than that?

Mr. POWELL. We can, with the necessary appropriations. We could do it in six years if sufficient appropriations were made.

Mr. STEWART. You could locate the reservoirs in five or six years?

Mr. POWELL. Yes, sir; we could make the maps, outline the catchment basins, and lay out upon the ground the head-works, the canals, and the reservoirs in six years, with sufficient appropriations.

Mr. STEWART. Do you not regard that as the most urgent work?

Mr. POWELL. Yes, sir.

Mr. STEWART. Because then settlement can take place, and the geological part of the work could go on afterwards just as well.

Mr. POWELL. Oh, yes. We are pushing the topography very far ahead of the geology all the time.

Mr. STEWART. Then, if you had the requisite appropriations you could locate the reservoirs and make the surveys for settlement in five or six years?

Mr. POWELL. Yes, but it would take about \$5,125,000 to do it.

By the CHAIRMAN :

Q. At the rate of about \$1,000,000 a year?—A. That is my estimate.

Q. That would complete the topography?—A. It would complete the topography. I have made a second estimate. I have been working the last three days on it.

Q. It would complete the surveys of the basins and districts?—A. Yes, the catchments.

Q. And locate reservoirs, canals, and so on?—A. Yes, sir.

Q. In other words, the additional cost of this contemplated survey would be about a million and a quarter dollars over and above what you are now doing in the way of topography?—A. Precisely.

The CHAIRMAN. It will cost \$4,000,000 to complete this area?

Mr. TELLER. Anyhow.

Mr. POWELL. Anyhow, for topography.

Mr. HALE. And it would take thirty years the way they are doing it now.

By the CHAIRMAN :

Q. Of course topography is the first thing?—A. Topography is the first thing.

Q. It is the essential thing?—A. And the chief cost.

Q. If you run this whole area into a six years' term, you must spend your \$4,000,000 for topography, and then the remainder of the work can be done for a million and a quarter?—A. It could be done for a million and a quarter, according to my estimate, and could be done *pari passu* with the other work.

By Mr. HALE:

Q. In round numbers it would cost about a million dollars a year?—A. About a million a year; but we could not use a million this year, because the engineers are not trained yet; they would have to grow.

Thus it was with a full understanding by the members of the Appropriations Committee, and by the chairman of the present Irrigation Committee, who was present at the interview, that this appropriation of \$100,000 was made to be chiefly expended in topographic work. It will be remembered that this appropriation was made on the 2d day of October, 1888. On the 30th day of December following the Director made a report to Congress on this subject, which was printed and referred to the Appropriations Committee for their information. It is a document of twelve pages. In it the Director reports fully how he has inaugurated the work of the irrigation survey, and how he is using a part of this \$100,000 in topographic work. The following quotation is made from this report:

The necessary topographic work was placed under the charge of A. H. Thompson. A number of topographers already employed in the Geological Survey were selected as his chief assistants, and the force was largely increased by the employment of temporary field assistants, but no increase of the permanent corps was made. Under the direction of Professor Thompson the following described work has been done:

WORK IN MONTANA.

Work was commenced on the Continental Divide at the headwaters of the Columbia and Missouri Rivers early in October, one party surveying on the Columbia River side and another on the Missouri River side. The whole was under the immediate charge of Mr. E. M. Douglas. An area of 2,200 square miles has been surveyed. The topographic features of this country were delineated, the courses of the streams and the sites of all considerable bodies of water were ascertained, and the altitude, position, and general character of irrigable lands were determined. This is a region of abundant perennial streams, and many sites favorable for the establishment of storage reservoirs have been surveyed.

WORK IN NEVADA.

Early in November Mr. H. M. Wilson, with the parties under his immediate charge, previously engaged on topographic work in the gold-belt region of central California, was transferred to Nevada, near the headwaters of the Truckee, Carson, and Walker Rivers, and immediately began the work of an irrigation survey. This is a region where mountain waters are in great abundance, but where lands to which they can be economically conveyed are limited in extent. Up to the present time the survey of an area of about 800 square miles has been completed. Work will be continued as late into the winter as the season will permit and resumed early in the spring of 1889.

WORK IN COLORADO.

In the latter part of October, and immediately on the passage of the act, a party in charge of Mr. Anton Karl commenced work on the South Platte River. The season was too far advanced to enter the mountain region, so the survey was confined to the foot-hills and the plains extending eastward, embracing the city of Denver and a portion of the great agricultural district of Colorado. About 1,400 square miles have been discovered.

In this region the waters of the South Platte are already employed in the irrigation of many districts, and the entire volume of the river during the irrigating season is utilized in serving the lands for agricultural purposes. The future development of agriculture in this country is dependent partly upon such an improved construction of irrigating works as will prevent waste and loss, but chiefly upon the construction of reservoirs to hold the waters which through the remainder of the year now flow to the sea without performing their duty to agriculture. The topographic work in this region is now suspended, as it can not be economically carried on in the winter, but it will be resumed in the spring.

Early in October a large party, under charge of Mr. W. D. Johnson, was sent to Colorado to operate in the valley of the Arkansas, and work is being prosecuted with vigor. An area of about 1,500 square miles has been surveyed. It embraces some regions which have already been redeemed by irrigation, but which can be further developed by better utilization of the great flow of the Upper Arkansas and by the storage of waters in the higher mountains and the foot-hills. The upper portion of the Arkansas, unlike that of the South Platte, is well adapted to this purpose, as there are many valleys, morainal lakes, and basins that can be economically utilized for storage basins. On the South Platte much of the stored waters must be held in lakes created in the foot-hills and on the plains, while the waters of the Upper Arkansas can be held high in the mountain lands, where in many ways the conditions are more favorable and the engineering problems less difficult.

WORK IN NEW MEXICO.

At the time of the passage of the act above mentioned, parties under Mr. A. P. Davis were at work in New Mexico, making topographic surveys of certain mountain regions. These surveys were on methods adapted to the purposes of the irrigation investigation, and it was therefore only necessary to enlarge the scale and extend the work into districts of irrigable lands. The entire work of the season is therefore available. The region embraced is that drained by the Jemez River and other tributaries of the Rio Grande rising in the Tewan group of mountains. The most northern river of this series is the Chama, which has its confluence with the Rio Grande above Santa Fé. The most southern is the Puerco, having its confluence with the Rio Grande below Albuquerque, and between these rivers the Jemez and other streams join the Rio Grande. At the writing of this report an area in this region has been surveyed topographically having an extent of about 6,000 square miles.

From the above it will be seen that, although the act for the irrigation survey was not signed until October, and the season favorable for surveys in middle latitude was almost past, yet the work was immediately pushed with vigor, so that at the close of the calendar year five considerable tracts of country have been surveyed—one in Montana, another in Nevada, a third in the Platte Valley of Colorado, a fourth in the Arkansas Valley of Colorado, and a fifth in the drainage basin of the Rio Grande, in New Mexico.

After the Director had thus reported to Congress that an irrigation survey needed a topographic survey, had drafted a clause in such a manner as to authorize and direct that a topographic survey should be included in the irrigation survey, and had appeared before the Committee and explained the matter fully, the clause was incorporated in the bill and finally became a part of the act that was signed by the President. Thereupon, in good faith, and in compliance with the law, the topographic branch of the Irrigation Survey is organized and its work is begun, and thereupon the Director reports to Congress what he has done, and fully and elaborately sets forth where and how he is doing this topographic work.

Still this history continues. The Director made a second estimate for an appropriation for the Irrigation Survey, in the same terms in which the first appropriation was made, and once more he was called before the Senate committee to explain his estimates. On this occasion he appeared with samples of his work, a topographic map and plans for reservoirs and canals, and he explained them to the committee, virtually saying, "This is what I am doing with the funds intrusted to my charge." The statement made on this occasion by the director was recorded by a stenographer and incorporated in a report of the committee to the Senate, and printed as a part of that report. (See report submitted by Mr. Allison before the Committee on Appropriations, Fiftieth Congress, second session, No. 2613.)

From a long and interesting statement made by the Director on that occasion the following extract is given :

The CHAIRMAN. Now go back a moment to this map. What will it cost the Government to locate the reservoirs and canals and make the plan for them, which I suppose, in a general way, at least, would be done? They would be located absolutely, so that the men who chose to build these dams would know where to go precisely?

Mr. POWELL. Yes, sir.

The CHAIRMAN. If they chose to build a canal it would be laid out for them practically?

Mr. POWELL. Yea, sir.

The CHAIRMAN. On a map and in the field, would it not?

Mr. POWELL. Not in the field.

The CHAIRMAN. You would not locate it?

Mr. POWELL. With a topographic map, laying it out on the map is laying it out in the field.

The CHAIRMAN. Practically?

Mr. POWELL. Practically. That is the advantage of a topographic map.

The CHAIRMAN. There is a region to be reclaimed practically of 153,000 acres. What would it cost the Government to do that?

Mr. POWELL. I dare not make an estimate. I can not make an estimate from that one, because I have made a geological study of that region myself in the field. I knew just what I had to do. I knew where I had to go to make these plans. They were already practically made.

Senator HALE. You could do this much more easily and less expensively than in an unknown region?

Mr. POWELL. Oh, yes; that did not cost more than \$8,000, for I knew all about it from previous study.

Senator HALE. You selected this place because you knew it?

Mr. POWELL. Because I knew it. I did it in a hurry, so as to have something to show you.

The CHAIRMAN. That is, I take it, an illustration of what you propose to do throughout this entire arid region?

Mr. POWELL. Precisely.

The CHAIRMAN. Having conditions of reservoirs and water?

Mr. POWELL. Yes. You asked me for an estimate of what it would cost. I made the best estimate I could last year for the entire country and you published it; but you put into the law much more than I anticipated would be put into it, so that the cost of the work has been increased above my estimate. I did not anticipate that I should be called upon for plans of reservoirs, but only for putting upon the maps the sites. I did not anticipate that I should select the lands in such a manner that they could be designated to the Land Office. As the law stands, I have to go on the ground and discover the land-marks of the old land survey, so as to show what sections are to be reserved, and that has increased the cost of the work. My judgment is that, for the whole region, it will increase the total cost about \$1,500,000.

The CHAIRMAN. What we propose?

Mr. POWELL. What you propose.

The CHAIRMAN. And that is a very important thing to do?

Mr. POWELL. It is a very important thing to do.

The CHAIRMAN. In having these men in the field selecting places for storage and so on, do you also find yourself able to utilize them in carrying on in connection with this work your regular geological survey?

Mr. POWELL. So far as the making of the topographic maps is concerned. The maps have to be made for this purpose as they would have to be made for the other, and all the map-making for this work is map-making for the other.

The CHAIRMAN. After this work is done would it be necessary to go over the same space in completing your geological survey?

Mr. POWELL. Yes, sir.

Senator HALE. Which would you naturally go over first?

Mr. POWELL. This work now, because they are pressing for it, and there is no reason why it should not go first.

The CHAIRMAN. I did not know but that the same men might do both.

Mr. POWELL. It must be understood that more than half of the cost is for the map-making, and that is done for both surveys at once.

Senator HALE. There you do not duplicate the work.

Mr. POWELL. There we do not duplicate it. That is more than half the cost of the whole work. The engineers who make these plans are not geologists, and geologists are not engineers. You can not get the same men to do the geological work and the engineering work.

Senator HALE. If a given region that is adaptable to this purpose had been gone over by your geological survey, would not that work really help you in this?

Mr. POWELL. That would have given me the maps and given me data which would have greatly diminished the cost of this work, or doing this work first will greatly diminish the cost of the other. It amounts to the same thing either way.

The CHAIRMAN. That is the point I wanted to understand; whether the work that you are doing here is not a saving of necessary work in your geological survey?

Mr. POWELL. Precisely; it is.

Senator HALE. Either way that you work, whichever was done first would help the other?

Mr. POWELL. Whichever work is done first will help the other. The map-making is the first thing in each case, and the map-making is the chief cost.

The CHAIRMAN. Has not the House given you in the bill more money than you need?

Mr. POWELL. I wish to reach that point. There are eight States and Territories where agriculture is wholly dependent upon irrigation, where they raise nothing without irrigation; and there are six other States and Territories where they are chiefly dependent upon irrigation. If you give me \$250,000 I can go into six of those States only; I must make a selection.

Senator HALE. You mean there are fourteen States and Territories in all?

Mr. POWELL. Yes, sir.

Senator HALE. And six of those are partly dependent upon irrigation?

Mr. POWELL. Yes, sir. With \$250,000 somebody out there has to be disappointed. Their governors, their legislatures, their people are pressing upon me for this work. They are petitioning me and writing me, and there is a pressure upon me. With \$250,000 I have got to make a selection of six States and Territories and disappoint the other eight.

It ought to be understood why I say I can only go into six States. It seems to me to be important to take up three pieces of work next year and carry them on to such a point that I can exhibit to Congress next year what it means on a larger scale than I have shown here. So I propose on the Arkansas and a portion of the Rio Grande, and on the Walker River in Nevada, to put larger parties than elsewhere in order to get the work pushed in those regions as rapidly as possible. This shown to-day is on a very small scale indeed. I should need for that about \$175,000 for those three places. Then I can take the remainder and put it in three or four other States and Territories, and for these I must make a selection for a little beginning, and show that I am trying to do something for them; that is all I can hope for. But with \$350,000 I can go into all the States and Territories where irrigation is necessary throughout the region, and also go into California and Oregon. There is very little of California where irrigation is not needed, but I could go into all the States and Territories and into California and Oregon with an appropriation of \$350,000.

The CHAIRMAN. Do you find at hand thoroughly competent men to organize these field parties and put them at the work?

Mr. POWELL. I can to that extent. I have been urged very much to make my estimate \$500,000, but I said "I can not find the men in one year to do it." I have looked over the matter and I have found where I can get men in addition to what I have, so that I can utilize \$350,000.

The CHAIRMAN. You want \$100,000 more?

Mr. POWELL. I want \$350,000. I have one other thing to ask for in the bill, and that is that the appropriation be made immediately available.

Senator HALE. You want the money to start right on, I suppose; you do not want to wait until July?

Mr. POWELL. I do not want to wait until July.

The CHAIRMAN. You had \$150,000. Will not that run you until July?

Mr. POWELL. I had only \$100,000. If you will make \$30,000 or \$40,000 available, that will be sufficient.

Senator HALE. What have you left of the amount Congress gave you in the act of last year?

Mr. POWELL. About one-half.

Senator HALE. You have in hand \$50,000 of the appropriation made last year?

Mr. POWELL. Yes, sir.

Senator HALE. That you can use right away, in the spring?

Mr. POWELL. Yes, sir.

Senator HALE. You wish \$40,000 more to be immediately available?

Mr. POWELL. If I had from \$30,000 to \$40,000 more, I could do one thing which is all-important. The season of irrigation was already passed last year before the appropriation was made. The season of irrigation will be largely passed this year before the 1st of July, so that for this new work I will lose the observations to be made during the season of irrigation. I want to employ at once this spring in all the region of country river-gaugers, stream-gaugers, men who are gauging or measuring the amount of flow of those streams between now and the 1st of July, during the season of irrigation. I have money enough to keep all my other force at work.

Senator HALE. You can do this work to better advantage during the season when the streams are used for irrigation?

Mr. POWELL. The stream-gauging ought to be done then. The most important stream-gauging is that which is to be made during the season of irrigation. That is water which is not to be stored at all, you see.

After all this explanation, repeated again and again, explained in the clearest manner and exemplified by producing before the committee

the maps actually made, a second item was incorporated in the bill in terms identical with the first, except that the amount was \$250,000.

On the 30th of last July the Director submitted to the Secretary of the Interior a report, which report is submitted by the Secretary of the Interior to Congress through the Government Printing Office, as the statute directs. While yet this report is in the hands of the printer there is introduced into Congress a resolution calling for the printing of 20,000 copies of it, and this resolution is ultimately passed by both Houses and becomes a law, and under the resolution the report is printed, and it is now before Congress. This report fully explains the topographic work, the hydrographic work, and the engineering work—all of the operations of the Irrigation Survey under the appropriation of \$100,000. Thus a second report for this year's work has been made, and in it is contained an itemized statement for the expenditure of \$100,000, less \$135 on hand at the expiration of the year, to be covered into the Treasury. Surely it is a reckless statement that charges the Director of the Survey with any misapplication of this money, and from a long, careful, and patient investigation of this subject, we are fully warranted in affirming that the money has been expended strictly in compliance with the law; that the work has been prosecuted vigorously and economically, and that results of great value to the country have been obtained.

It will be seen from the foregoing statement that the strictures made on the Director of the Survey in the majority report, implying that he has failed to comply with the law in reporting to Congress, are not in accord with the facts. Within three months after the passage of the act the Director made a report to Congress setting forth the operations of the Survey under the organization of the work. Subsequently, on the last day of July, 1889, he submitted another report to Congress setting forth the operations of the Survey under the provisions of the act making appropriations for it, and giving a detailed statement of expenditures, and that report also has been printed and is before Congress. The report was not transmitted directly to Congress, but through the Public Printer, as the statutes direct. *Vide* U. S. Statutes at Large, Vol. 13, 184, an act entitled, "An act to expedite and regulate the printing of public documents, and for other purposes," approved June 25, 1864, of which the following is an extract:

That hereafter, instead of furnishing manuscript copies of the documents usually accompanying their annual reports to each house of Congress, the heads of the several departments of government shall transmit them, on or before the first day of November in each year, to the superintendent of public printing, who shall cause to be printed the usual number, and, in addition thereto, one thousand copies for the use of the Senate and two thousand copies for the use of the House of Representatives.

SECTION XXXVI.

THE TOPOGRAPHIC WORK OF THE IRRIGATION SURVEY IS NECESSARY AND ECONOMICAL.

The report of the majority also condemns the topographic work of the Irrigation Surveys as being unnecessary for the work contemplated in the statute creating the Survey, and it gives the opinions of sundry persons called before the committee, who thought that the topographic work was useful, but believed that it could be dispensed with, and that the same results might be reached in another manner. But these persons had no definite plans to propose—made no explanation of how the work could be otherwise done, but expressed the vague and general opinion

that they could do it better in some other manner which they could not define or state. Other officers of the Survey, who seemed to comprehend clearly all the work prosecuted by the Survey, were able to explain how the work is done, the necessity for all parts of it, the thorough and accurate results obtained by it, and the great economy of the methods devised. But Director Powell himself made a simple and clear statement of the whole matter in a manner that must be convincing to all persons not desiring to destroy the Survey for other reasons.

The following extract is given from the testimony of the Director :

FURTHER STATEMENT OF DIRECTOR POWELL.

The CHAIRMAN. Major Powell, the point that the committee desires your views upon this morning is as to the necessity of topographic surveys preceding the engineering surveys for irrigation, the relation of the two classes of surveys, and whether the engineering surveys can be carried on independently of the other, or whether they are necessarily connected.

Director POWELL. Mr. Chairman, there are two branches of the subject which I wish to present : First, the plans and methods of the survey, as necessary to carry out the provisions of the statute ; and second, I wish to call attention to and review the statutes and the reports which I have made to Congress on calls from the Senate, which represent the needs of an irrigation survey, for the purpose of showing that the wording of the statute and the representations made by me to the Congress prior to the passage of the statute are in harmony with what has actually been done. That is, I wish to show, first, what the irrigation survey should be, What is necessary to be done, and the information required ; and second, to show that before the passage of the law I had fully set forth the facts to Congress, and that the wording of the statute calls for the work which has actually been done.

The CHAIRMAN. We are not complaining of what has been done. We simply want to know how these surveys are dependent upon each other.

Director POWELL. These two lines I would like to be heard upon. First, then, I wish to address myself to the question, What is necessary to be done in an irrigation survey, and how can this be done in the most economic manner ? The statute provides, first, that the extent to which the lands can be redeemed by irrigation shall be determined ; second, that reservoir sites shall be selected ; third, that canal sites and sites of other hydraulic works, such as diverting dams, etc., shall be selected ; fourth, that the lands made irrigable by these hydraulic works shall be selected ; and, finally, that all of these sites and lands shall be segregated—that they shall be selected on the ground, as I understand it, and be certified to the Land Office, in land-office terms of township, range, section, etc., for the purpose contemplated in the law. In order to accomplish the end a survey had to be prosecuted and a series of discoveries made. These discoveries may be divided into three classes : Those relating to the land—the catchment areas, the sites for diverting dams and canals, the sites for reservoirs, and the irrigable lands. These necessities give rise to the topographic branch of the Irrigation Survey. Second, those relating to the water ; that is, it is necessary to determine the amount of water which can be used for irrigation in each hydrographic basin or area drained by one important stream and its tributaries. It is necessary to determine the mean amount of water for the irrigating season in each basin, and also the mean amount of water for the entire year, and it is also necessary to determine the minimum amount in seasons of excessive drought and the maximum amount in seasons of excessive rain-fall. It is also necessary to determine the amount of water required to irrigate an acre of land, that is, to determine the “duty” of water. The necessity for determining all of these facts in relation to water gives rise to the second branch of the Irrigation Survey, that is, the hydraulic branch. Third, those relating to estimates of the cost of dams, canals, and reservoirs. For this purpose the sites of the dams must be surveyed with accuracy and the constructive conditions as to the proximity and character of materials must be studied. The sites of the reservoirs discovered by the topographic survey must be carefully examined and plans for their construction made. The sites of canals, the general routes of which are previously discovered by the topographic survey, must be carefully run upon the ground and marked and the amount of cutting and filling determined and the ground minutely examined for the purpose of discovering its character, whether it be in sand, clay, gravel, or solid rock, as all of these facts affect the cost of the work. Having studied these facts the cost of construction can be properly estimated. These three classes of work all relate directly to the Irrigation Survey. They are all required by the provision of the statute, and no one can be neglected without disobedience to law. The three kinds of work give rise to three branches in its organization, which we call the topographic, hydrographic, and engineering branches.

The topographic survey is the work primarily necessary to the discovery of sites, though it has another use in the hydrographic survey, as will be shown when that point is reached. In investigating this subject for the purpose of determining the best and most economic method of discovering the various sites required, it was decided that a topographic survey was proper. If a specific reservoir site is already known, and the body of land to be served by the waters from that reservoir is already known, the simple problem is to find a way for a canal from the reservoir to the land. Such a survey would need only the work necessary to run a number of trial lines on the ground and then to select the best from these. But the problem before the survey was not to irrigate some one man's farm from some one stream or reservoir site; it was not to irrigate some particular piece of land to suit some particular person; but the problem was to discover all of the reservoir sites, all of the canal sites, and all of the lands that could be irrigated in any given hydrographic basin. How this could be done in the cheapest manner was the question which I had to solve. Having a specific reservoir in sight and a specific body of lands in view, and wishing to take the water from that reservoir to that piece of land, I can run trial lines and find the best route at the rate of about \$25 per mile for each of the trial lines; but the final line selected must be run again with great care, the whole ground must be studied, very exact levels must be run, and all the characteristics of the line must be determined, in order that the cost of the canal may be discovered. But in the work of the irrigation survey the reservoir sites, the canal lines, and the lands to be irrigated have all to be discovered—ten, twenty, fifty reservoirs perhaps in one hydrographic basin; scores of canal lines, 10, 20, 50, 100 miles in length. To run many such trial lines over the ground for the purpose of selecting a few would involve great cost. The system of discovering canal lines by a topographic survey instead of by a trial line survey is very much less expensive. Certainly it would not cost more than one-third of the amount. To discontinue the topographic survey and inaugurate a trial-line system would be to increase the cost of the work fully three times. In the same manner the reservoir sites are to be discovered, and their relation to the streams which furnish them water and to the lands which they are to irrigate must be determined. Some of these reservoir sites are in the mountains—the best are there; some are in the valleys and on the plains. They are therefore widely scattered throughout all parts of each hydrographic basin. To discover them by trial lines instead of topographic surveys with contours would be to increase the cost of the work at least three times.

A hydrographic basin may furnish only a half a dozen good reservoir sites, or it may furnish two or three hundred, as the case may be. Some will be small, sufficient for reservoirs to hold 1,000 acre-feet of water; others will be great, sufficient for reservoirs to hold 1,000,000 acre-feet or even 2,000,000 acre-feet of water. One reservoir site may be excessively expensive, another very economic; that is, it may cost \$10 per acre-foot of water to store it or it may cost but 10 cents per acre-foot of water to store it. It becomes necessary, therefore, for economy's sake, to select the best sites. In order to do this it is necessary to discover all of the reservoir sites of each hydrographic basin. If I were to select a score of reservoir sites in a basin at random and have these reserved to be used by the people in the future, and it should be found that half, or many, or all of them, were not so good as other sites in the same basin, and that a system of reservoirs could be constructed to store the water for one-half or one-fourth of the cost that would be required in the basins carelessly selected, the whole work would be repudiated by the people; it would be misleading and injurious. It is therefore necessary for me to know in each basin all of the reservoir sites in the basin, that the best may be selected. This means that I must know every valley in the basin.

To illustrate the method of discovering these reservoir sites, I have brought with me the maps constructed by the topographic survey in the upper basin of the Arkansas in Colorado. These are the maps constructed in the field. On examination you will see that they are in contour lines; that the vertical interval from one contour to another in the valley region is 25 feet, in the hill regions 50 feet, and in the mountain regions 100 feet. It is not necessary to do the work in the mountains with the same degree of refinement as in the valleys. For more than twenty years I have been engaged in making topographic surveys in connection with the other work under my charge. During that time I have employed a corps of men of ability and genius, and during that time I have topographically surveyed about a half million square miles of country, on various scales and with varied degrees of refinement. Through the inventive genius of the men who have been employed on this work new methods of survey and new instruments have been devised, so that the whole system of topographic surveying has been revolutionized, and to correspond with it the method of map construction has been greatly developed and improved. The work has been improved in quality and enormously decreased in cost, and gradually other nations of the world are adopting our system.

The topographic survey which we are making in connection with the Irrigation Survey is in most particulars the same that we are making for the Geological Survey.

The topographic work necessary for the one is necessary for the other, and we were making these maps for the Geological Survey before the Irrigation Survey was inaugurated. The cost of the irrigation survey, therefore, was only the cost of what was additional to the work already in progress. The work of the irrigation survey is, for the reason I have stated, in the first place a topographic survey, because the sites for the works and lands are to be discovered, and it is the cheapest and best way of discovering them. In the maps before you you will see that the topographers have discovered forty-three reservoir sites and marked them upon the maps. They are colored in blue. The contour lines are colored in light red, as you see, and the reservoir sites are determined by the contour lines. Each site represents a valley basin, and in general terms the height of the dam, the size of the basin, and its capacity are revealed by the maps which the topographers have constructed. From these about twelve or fourteen have been selected by the engineers as being, all things considered, the most eligible. The twelve or fourteen must be surveyed with greater care for the purposes already indicated, that is, to determine the cost of construction and to mark them upon the ground. That is the work of the engineering branch of the survey. In the same manner these maps reveal the general lines of the canals. They show, for example [indicating on the map] that the water from this reservoir can be taken along this line to this body of land. The map reveals other lines by which it can be taken, and shows that this one is the best, and the engineers have selected it and have actually run it upon the ground and obtained the facts necessary to estimate its cost.

When called upon by a resolution of the Senate for a plan for these surveys, and by the Appropriations Committee for an estimate of cost, I selected and recommended this method of prosecuting the work, because I believed it would be the most economic; and I estimated the cost of the topographic work, in addition to what had already been done in the country, to be about \$4,000,000. In making this estimate I took into view the fact that already work had been done under the general appropriation for the Geological Survey, and that that work would not have to be done again. I further estimated that to determine the amount of water in each hydrographic basin that could be used for irrigation and the amount of land which could be irrigated thereby would cost an additional sum of \$1,500,000; and, finally, when it was decided by the committee that the sites should be surveyed for the purpose of estimating costs and of segregating the lands and reporting them to the Land Office as reserved under the provisions of the act, another \$1,500,000 would be necessary, making in all for the irrigation of the arid lands the sum of \$7,000,000. But this estimate was based upon the consideration that the work should be done in the manner which I have pointed out. If this cheap and comparatively accurate topographic method developed in the survey had not been known, and had the old methods of topographic surveying been in vogue, I should then have had to decide whether it was cheaper to make the discoveries of sites by the old method of topography or by the system of running trial lines; but having developed a more economic topographic method, it was only necessary to decide between this new method and the trial-line system; and the new method is by far the cheaper and in every way the more satisfactory; for, having done it, the entire work can be published and submitted to the people—not as the opinion of men engaged in the work, but as facts determined by instrumental survey—and presented by simple contour lines on maps, so that they can see for themselves all the facts and conditions.

Senator JONES. What is the scale of those maps?

Director POWELL. One inch to 1 mile. That is the field scale. We do not publish on that scale. It is reduced to 2 miles to 1 inch for publication.

The CHAIRMAN. Right in this connection let me make an inquiry. You have got these drainage basins mapped. Now, suppose an engineer should go into one of these drainage basins with such maps as you have, would it not be necessary, in order to do accurate work, to follow up the stream and work carefully over this ground again, to determine where to locate his reservoir and canals?

Director POWELL. No, sir. I will come to that.

The CHAIRMAN. Then could not an engineer, with the boundaries of the drainage basin indicated, go into the drainage basin and make accurate surveys and locations; or even if they were not indicated, could he not determine the boundaries of the drainage basin and do the mere engineering work with a view of practical work?

Director POWELL. No, sir; the engineer—

Senator JONES (interposing). This dotted line on the outside indicates the watershed. [Pointing to map.]

Director POWELL. The dotted line is the catchment area. That shows what will feed this reservoir. [Indicating on map.] I will come to that in the latter part of my statement. I want to answer the chairman. An engineer who should go in there without the topographic map would have to select the site. If he went in to select

the site he would have to select it by running trial lines, and to run trial lines would cost three times this. Now, when he comes to this reservoir the engineer surveys it, but not all this catchment area. Instead of surveying the area outlined here he surveys this area, the dam site itself only, and surveys it in a minute manner. The topographic survey has found the reservoir site and the catchment area. The engineer has all the facts. Now, the engineer who goes in there runs a more careful line to find the amount of water that reservoir will hold and the length and height of dam necessary, and that is all he has to do.

Senator JONES. In order to make an accurate reservoir is it not necessary to run those minute lines?

Director POWELL. Certainly.

Senator JONES. Before the people can go in and occupy the lands these lines have to be run?

Director POWELL. Yes, sir, those in that little basin; but we have saved him all that work [indicating on map], and have done it in the cheapest possible way.

Senator JONES. This work of setting apart and getting the areas is pretty much done all over the country, is it not?

Director POWELL. No, sir; nowhere in the United States except where I have made surveys.

Senator JONES. Have you not had the engineering work in certain cases precede your topographic surveys?

Director POWELL. Yes, sir, I have, and that I wish to refer to. On the passage of the act the people of the western region were exceedingly anxious to have results. In the general study of this subject for the twenty years in which I have been engaged, and during which Mr. Gilbert, my first assistant, has been engaged, I knew of very many sites; they did not have to be selected. I knew that Providence Lake was a site; I knew that Utah Lake was a site; I knew that Hope Valley was a site; I knew that a number of localities were sites; but I did not know all, only a small number. I set the engineers at work on places which I already knew, in order that I might meet a local want at the very earliest day; but still they had in each of those cases to run trial lines, and the money expended in those unnecessary trial lines, if I could have had the topography of the sites which I already knew, would have paid 50 per cent. of the cost of making the map. If I had had a topographic map even of the sites which I already knew I could have saved enough in the running of trial lines to have paid 50 per cent., or one-half, of the cost of the map, and that has been demonstrated over and over again on the Arkansas and on other rivers. The greatest waste which I had in that manner was in Nevada. The engineer who went there ran unnecessary trial lines, as the chairman knows. He was the first man to raise an objection to this work; he organized the movement against the topographic work and wasted money in running unnecessary trial lines.

The CHAIRMAN. When an engineer runs his trial lines for his ditch he must be governed by something besides topographic maps, must he not?

Director POWELL. No, sir. Suppose that I have selected the reservoir and the land. That had to be done first. Now I want to know how I am going to get the water from that reservoir to that land?

The CHAIRMAN. Can you select the land before you know definitely where the ditch is to be located?

Director POWELL. I can with a topographic map; otherwise I have got to run trial lines, either one or the other. Without that map I must run trial lines. To make selections by running trial lines is to increase the cost of the work three times.

The CHAIRMAN. Can you select with sufficient accuracy to enable people to locate on the lands?

Director POWELL. I can.

Senator MOODY. In making these topographic maps you run these lines, do you not?

Director POWELL. Yes, sir. I run them with plane tables by methods which we have developed in the Survey. To explain it would require a long trigonometrical statement. Let me further say that in addition to the discovery—

Senator MOODY (interposing). Right here let me ask, can you run a line with such accuracy as to enable the engineer to follow any line without himself running levels and lines in the usual way with transit and levels?

Director POWELL. Suppose that we have a reservoir at one point, and some land at another point, 10 miles away. I can say from the topographic map that the best line that can be made from that reservoir to that land must run along that hill and meander down that valley, and down that hill, through that valley, to that land—

Senator MOODY (interposing). You could do that with the eye.

Director POWELL. And having done that, the engineer ultimately runs over that ground, and from the reservoir site to the lands, for the purpose of doing other thing. The statute demands that we shall furnish an estimate of the cost. The en-

gineer has to go over the ground and determine the nature of the soil, the nature of the excavations which will be required, what amount of cutting there must be in one place, and what amount of filling in another place, and so on, in order to get at the cost of constructing that canal; but the site of the canal is selected from the map, without any trial lines whatever. I have in my office, Mr. Chairman, three classes of men—

Senator REAGAN (interposing). That is the same method that is observed where a preliminary survey of a railroad is made, the details being attended to afterward?

Director POWELL. The first thing is to make the selection, as we would in the case of a railroad survey, by trial lines, or by topographic surveying, ultimately selecting one, and then make an accurate survey of it. I have adopted the method of discovering the sites which is the cheapest of all. But, Mr. Chairman, the topographic work is an important part of the irrigation survey for other reasons than those already explained, and such reasons are even more potent. The amount of water furnished by a hydrographic basin must be discovered. If a reservoir is to be constructed it must be known how much water can be furnished it annually before its size and the character of its works are determined. To select the lands to be irrigated I must know how much water there is to serve and how much water each acre of land will require; that is, the amount of water and the duty of water. In general, there is more land than the water can serve. Only one-eighth or one-tenth of the country can be irrigated, because there is not enough water to irrigate more. I must find out how much water can be got to serve that land. How would I do this? This was the most difficult and complex problem presented to me when the survey was inaugurated. How could we gauge all the rivers, creeks, and brooks of two-fifths of the area of the United States—all the waters flowing in the streams of that region—in order that works for their control and use might be constructed and lands for them to serve might be selected? There is a vast number of these streams, as will be seen by a review of the entire ground. To gauge one stream means what? It means that we have to discover the velocity of the current, which varies from shore to central line and which varies from top to bottom, so it becomes necessary to determine the velocity of the current in every part of the cross-section of the stream, because the flow is not uniform, it being greater in the center and less at the sides and bottom, but exceedingly variable for the different forms of cross-sections. Supposing it to be gauged in this manner on one day of the year, that night a rain falls and the stream is enlarged, the entire conditions are changed, the cross-section is larger, and the velocity of the current is greater. So it changes from hour to hour and from day to day, rising with the rains and falling with the droughts.

To find out how much water flows down the stream during the year it is necessary to find out how much water flows in that stream at every stage of its volume, from the lowest water to the highest water. This is done by the use of current meters. Then it is necessary to employ a river-height gauge to determine how high the water is at each hour of trial, and having discovered how much water flows at each stage and how much time it remained at each stage, we are able to determine the total flow of the year. But some years are dry, other years there is great rain-fall; so the streams vary from year to year, and their volume in minimum years must be determined, and their maximum volume, and their average volume from year to year. To gauge the flow of each river and brook in the manner which I have indicated would require an enormous outlay of money, so great that when I studied the problem, as I did before the survey was organized and before it was authorized by Congress, I reached the conclusion that the work could be done in another and cheaper manner, and in a manner altogether more satisfactory. I reached this conclusion after a very careful study of the subject myself and after having submitted it to other gentlemen associated with me. The same conclusion was reached by all the gentlemen except one; that was Captain Dutton. The plan was to make a topographic survey of the catchment basins which should determine with reasonable accuracy their area, with reasonable accuracy their declivities or slopes, and to gauge a few of the streams in the manner which I have indicated, and to find therefrom under varying topographic conditions and varying altitudes and varying rain-falls, the amount of water which could be derived from each square mile of the territory of the basin.

Permit me to make this plain by the use of an illustration which will serve well for that purpose and better than a long discussion of the subject by which the scientific methods might be elaborated. Suppose I wish to know how much water there is running annually from the roofs of the houses of Washington. Shall I put a water-spout on every roof and gauge each one for every day in the year and for a series of years in order to get the mean annual flow? Such was the plan advocated by some of the engineers, but such was not the plan adopted by myself. Now, suppose I gauge the amount of water which falls from the roofs of a dozen houses in Washington, or even a less number, so as to get a good fair average of what every square yard of roof surface will deliver during the year. I can then easily determine how much water a

square yard of roof surface will furnish during a year; and having found that a yard of surface, for example, on a general average, will furnish a yard of water 30 inches in depth during a year, I have the means of determining the amount of water which any roof in the city will afford by simply measuring that roof. This is certainly a very much simpler and just as satisfactory a method as to put a current-gauge on every water-spout of the city. To do the work of the survey by gauging all the streams would cost an unknown sum, but certainly not less than \$10,000,000. So I determined to gauge a few typical streams and measure their catchment areas; that is, to determine the extent of catchment area and, to base the computations of water supply upon the factors thus developed and from the factors derived from the measurement of rain-fall. But it is necessary not only to measure the superficial area of the catchment basin, but also to determine the declivity or slopes of the ground by which the water would be gathered into streams and delivered to the irrigating works. The necessity for determining this element can be very simply explained.

The CHAIRMAN. The hydrographic survey is different from the topographic, to some extent, is it not?

Director POWELL. No, sir. A hydrographic survey is a topographic survey, but something more is added. A hydrographic survey determines the areas by a topographic survey. I was trying to explain that in my illustration of the roofs of the houses. I have to measure the roofs of the houses, from which the area of the roofs, the catchment area, is determined. It is the method of determining the areas which supply these basins. But there is another thing—

The CHAIRMAN (interposing). You have to approximate the area of the basin, do you not?

Director POWELL. It is not sufficient to approximate the area. It is necessary to determine the declivities. That is a problem which seems very simple when it is stated; but you will find that we have to determine the slopes of all the hills for the purpose. Suppose the rain falls over a district of country that is level, or nearly level, in that arid region, no great quantity of that water will flow into a reservoir. It will be gathered up so slowly into pools that it will all evaporate. But suppose it is like that of the Hassayampa, of which the dam has just been swept away. Then all the water which falls upon the catchment area, after the soil is once saturated, will immediately be gathered into the reservoir. It is a region of steep declivities. Here is the source [indicating on the map]. Here is Mount Tritle; here are four great mountains encircling the basin. When a great storm comes on those mountains the water rolls down into the basin. They sometimes have storms in that western country which will give 2 inches of rain-fall in two or three hours. The Hassayampa dam drained a mountain declivity of 325 square miles of nearly naked rock. When the big storm came it only required seven or eight hours by my computation to bring the maximum supply of water against that dam. The maximum supply of water against that dam was $6\frac{1}{2}$ acre-feet per second. There was that much water coming down every second for nearly an hour. Provision had to be made for it, and the declivity had to be known in order to construct the work properly. It was not only necessary to provide a proper way to dispose of the surplus water when it came, but also to know how much water could be stored there. If it had been a flat country there would have been no need to make a dam there, for no water would come down; but it being a steep country, a vast amount of water could be collected.

Now to make my illustration from housetops complete, suppose that the flat housetop is covered with a great thickness of sand, so that all the rains falling thereon are absorbed and finally evaporated by the sun. Then from such tops no water can be caught in the spouts. Suppose that others have varying declivities, and that the greater the declivity the less the amount of sand, until some are so steep that no sand will remain on them. The steep roofs will deliver all their water. Now similar conditions are found in the natural slopes of every drainage basin of the West. Some regions are so flat and sandy that the waters all evaporate, and nothing can be obtained from them; others are so steep and rocky that almost the entire rain-fall is discharged into stream-channels. It is wholly a question of declivities, and we are therefore compelled to determine these declivities. We want areas of catchment basins and declivities of catchment basins. To get these we make a topographic survey, in the cheapest manner that it can be done to be useful to properly solve the problems. The plan, therefore, is to measure drainage basins and determine their areas and declivities, to see what water they will shed in the streams; then gauge a few typical streams with accuracy, and with these facts—and some collateral ones which need not be here explained, as that would complicate the subject too much for simple statement—we have the data necessary to plan the works to control the water, so that it can be put upon the land.

On this subject the opinion of the Superintendent of the Coast and Geodetic Survey, who is an eminently practical, scientific man, and familiar with such survey methods, was asked, and the following letter has been received in reply :

UNITED STATES COAST AND GEODETIC SURVEY,
Washington, D. C., April 28, 1890.

SIR : I am in receipt of yours of yesterday, asking my opinion of the propriety of making a topographic survey as the basis of hydrographic and engineering work in connection with the irrigation survey of the arid lands now in progress, and whether in my judgment the plan thus far pursued is, on the whole, wise. In reply, I have the honor to submit a brief statement of my views upon the subject, as follows :

The vast extent of this irrigation scheme, together with the fact that it is the evident intent of the Government in its organization and prosecution that the interests of the whole people are to be conserved, and that no particular portion of the arid area is to be favored above any other portion, gives to the investigation that broad and general character which not only justifies but requires its prosecution in accordance with the well-recognized principles of research.

Considered from this stand-point, it seems to me impossible to avoid the conclusion that a topographical survey or reconnaissance of the whole area under investigation is a necessary preliminary to the wise and economical expenditure of money in engineering operations.

The interests at stake are so extensive that the method of investigation employed should be one which would result in the discovery of the truth, the whole truth, and nothing but the truth. A topographical survey or its equivalent is alone adequate to this. If it were simply desired to ascertain if a particular tract of land was susceptible of irrigation by the utilization of a particular stream, or whether a particular basin might be used as a storage reservoir, a less exhaustive and less expensive method might well be chosen. But it is assumed that the scheme contemplates the discovery and indication of all lands susceptible of irrigation, the location of all proper sites for reservoirs, and especially the selection of the best of these, economy and efficiency being considered ; in a general way it should reveal all competing lines for diverting water by canals and discriminate among them. In short, the exploration should be of such a character that nothing of value could escape it. A trial line of levels answers a definite question in a perfectly definite manner, but the information which it yields is of two dimensions, while that furnished by topography is of three. It is quite probable that in the prosecution of the work results of immediate practical value would be reached more quickly by ignoring the general principles which should control it, especially in parts of the country where some topographical information is already at hand, but while, in such localities, the engineer may do well, he can have no means of knowing that he might not have done better, unless, indeed, he should extend his examination until it becomes equivalent to a topographical survey, in which case it will become vastly more expensive.

A topographic survey is equivalent to an infinite number of lines of leveling of an accuracy depending largely on its cost. When executed in sufficient detail and with proper skill the limit of its accuracy depends upon the constancy of the dimensions of the sheet upon which it is represented, and it satisfies nearly every requirement of the most elaborate engineering operations. Again, it may be very cheap and only roughly accurate, exhibiting only in the most general manner the principal features of the country. A survey of the first type would be very expensive, but would leave little to be done by the expensive methods of the engineering parties, while one of the latter type or none at all would leave everything to the engineers, who must, if their work is exhaustive, make the equivalent of a topographical survey by methods relatively very costly. Between these two extremes of maximum expense lies a mean of minimum cost, in which the end is reached through a preliminary topographic survey of sufficient accuracy to reveal all of the irrigable lands, the available reservoir sites, diverting canals, etc., thus locating and restricting the operations of the engineer. This is, as I understand it, the plan proposed and adopted by the Director of the Geological Survey, and in my judgment it is, on the whole, wise.

Yours, respectfully,

T. C. MENDENHALL,
Superintendent.

Hon. J. H. REAGAN,
United States Senate.

SECTION XXXVII.

THE HYDROGRAPHIC BRANCH OF THE IRRIGATION SURVEY SHOULD NOT BE TURNED OVER TO THE SIGNAL SERVICE.

In the majority report it is proposed to transfer the hydrographic branch of the Irrigation Survey to the Signal Service, but the bill is silent on this subject. How the work ought to be done is not stated. The following is the recommendation made in the report:

OBSERVATIONS NEEDED ON CLIMATOLOGY.

The Secretary of Agriculture must deal with the climate, the soil, and the products, and employ a large force to collect and diffuse information with regard to all matters pertaining to the production of crops and the cultivation of vines and fruits. The Agricultural Department is particularly charged with collecting and diffusing information with regard to modes of cultivation and fertilization of the soil. Irrigation is a great fertilizer, and the proper application of water to the soil is a matter of the first importance to farmers. This relates to agriculture and not to geology.

In addition to the purely engineering work connected with irrigation, it is necessary to know approximately the amount of water discharged from each drainage basin, in order to estimate the quantity of land that may be irrigated; and it is also of importance to know the maximum discharge in time of great floods, in order to make ample provision in strength of works and extent of waste weirs to avoid accident. This branch of the service is called hydrography, and it is the subject least understood in the arid regions. Since it has been determined to transfer the Weather Service Bureau to the Agricultural Department, the employes of that bureau, and the army of volunteer observers connected therewith, can collect without any material additional expense to the Government all the information necessary on this subject. No other department of the Government is prepared to perform this service without an independent corps of observers. In a very short time the employes of the Weather Service Bureau will be able to do all that is required in measuring the streams and observing the climatic conditions with but slight supervision.

If an irrigation survey is not to be made under authority of the General Government, if no topographic map is to be constructed, if the head-work sites, canal sites, reservoir sites, and irrigable lands are not to be segregated, if plans for the construction of the works are not to be made and the cost of the same determined, if the real work of the irrigation survey is to be discontinued, the general observations made in relation to climate by the Signal Service may go on as they are with propriety; but if a hydrographic survey is to be made by the Signal Service, or by any other organization, a topographic survey is necessary for it. It is true that the volume of water carried by the streams in detail can be determined by another method, that is, by direct gauging; but, as shown by the Director and by all those persons who seem to have been competent to discuss the subject, and who have appeared before the committee, all persons who have had definite plans for the work, to make a hydrographic survey by direct gauging would be enormously expensive, and if made would be less valuable than if accomplished by the simple, practical, and inexpensive method recommended by the Director.

If the hydrographic survey is to be made by the Signal Service, its present officers in the field can not be utilized for this purpose; they must be at their stations to make observations on temperature, winds, rains, and barometric pressures from time to time during each day. Their stations are in the cities, not out in the mountains where reservoirs are to be constructed and on the banks of streams distributed all over the arid lands. It is possible that this suggestion was not intended as a measure to be adopted, for it was not incorporated in the bill,

but appears only in the report, and that the object of placing it there was that it might be used to destroy the present survey.

It is suggested in one paragraph of the report of the majority that it is proposed to have an irrigation survey in the Agricultural Department. Such suggestion is contained in the following paragraph:

The committee, believing that irrigation pertains to agriculture and not to geology and other subjects under the charge of the Director of the Geological Survey, and differing from the Director as to the mode of conducting such matters as relate to irrigation, have provided for the transfer of the Irrigation Survey to the Agricultural Department, and the appointment of a Commissioner of Irrigation in that Department.

It also provided in the bill recommended by the majority that in addition to a Commissioner of Irrigation "there shall also be appointed by the Secretary of Agriculture, on the nomination of the Commissioner of Irrigation, a sufficient number of engineers, clerk, and other employé to execute such laws relating to irrigation as have been or may hereafter be passed by Congress."

If the effect of this paragraph is to transfer the work of the present Irrigation Survey to the Agricultural Department, it transfers it all—topographic, hydrographic, and engineering.

The effect of the bill referred to will be the transfer of the Irrigation Survey with all its present functions from the Interior Department to the Agricultural Department, or to stop all topographic, hydrographic, and engineering investigations, and to have only an artesian-well survey, of which mention will hereafter be made. Considered in the light thrown upon the bill by the report, it seems possible that the intention is to secure the latter effect. The effect of the bill is to turn all lands and waters over to irrigating companies and wealthy men, and to give the ranchmen access to all waters. An engineering survey which shall locate on the ground the headworks, canals, and reservoirs, and make plans for such works and compute their cost, should not be made in the interest of irrigating companies. The report and the bill must be taken together, and the practical effect of the two must be considered, and this may be stated in the following manner:

(1) The nomadic ranching companies shall have the right of way to all waters in the arid lands, that they may destroy the pasturage and burn the forests, and perpetuate for an indefinite time the conflict between actual settlers and themselves.

(2) The great tracts of irrigable land now unoccupied along the major streams shall be turned over to the control of irrigating companies, indirectly through the acquisition of the water rights and by making the farmers subservient to their interests, or directly by their ultimately acquiring possession of the lands.

(3) The lands found in the neighborhood of districts already irrigated shall be acquired as homesteads by wealthy men, able to pay the enormous mortgages which the bill places upon them.

(4) To secure all this, it is necessary to destroy the Irrigation Survey and practically annul the provisions of the legislation already enacted, by which the sites of the irrigating works are selected and reserved for the ownership and use of the people, by which the irrigable lands are selected and reserved for homestead settlers, and by which the settlers are furnished with plans for works or informed of their cost; and this is consistent with the theory that these should all be turned over to corporations.

SECTION XXXVIII.

THE TWO BILLS ARE DIAMETRICALLY OPPOSED IN THEORY, PURPOSE, AND EFFECT.

The bill of the majority makes the arid lands the theater of wild speculation, and is opposed to the interests of the people, and is not in harmony with the sentiments of the people. The bill of the minority provides that these lands and waters shall constitute a sacred trust, to be administered in the interest of the people who are seeking to make homesteads thereon, and that they shall have the lands, the waters, the forests, and the pasturage.

Under the provisions of the majority's bill companies operating with foreign capital will build the works and organize immigration bureaus, as they are now doing, and the vast value given to these lands by putting water upon them will fall into the hands of promoters and speculators. Under the provisions of the bill formulated by the minority the lands will be held by the General Government, the irrigable lands to be transferred severally by small tracts to actual settlers, and the timber lands and pasturage lands to be held as a perpetual reservation to supply water, lumber, and pasturage to the farmers on the irrigable lands.

The bill of the majority devotes the arid region with its waters and lands to the use and benefit of such men and companies of wealth as shall first seize upon them and build up a system of large land holding in the hands of great companies, to whom the occupants of the land must be serfs. The bill of the minority, if enacted into law, will devote this great region with all its magnificent possibilities to the establishment of American homes.

SECTION XXXIX.

DIRECTOR POWELL DOES NOT SUGGEST THAT IRRIGATION SHOULD BE CONTROLLED AND THE WORKS CONSTRUCTED BY THE GENERAL GOVERNMENT.

The majority make the following statement in their report:

The passage of this bill, it is believed, will enable the bona fide settlers and land owners to develop the arid region by their united efforts. It will give full play to the enterprise of the pioneers of the West. It avoids, as far as possible, Government interference, and frees the Government from the enormous expense which would be involved if the United States should undertake the supervision and control of this vast region as suggested by the Director of the Geological Survey.

It can not be doubted that the effect of the bill "will give full play to the enterprise" of the promoters of irrigation schemes, and it does avoid, as far as possible, "Government interference" with the acquisition of water rights for irrigation by monopolies. The statement of the majority, quoted above, implies that the Director of the Geological Survey recommends that "the United States should undertake the supervision and control of this vast region." No word of such recommendation appears in the statements made by the Director to the committee and published with the two reports. On the other hand, the Director has clearly expressed his opinion that it is wise to turn over the entire control of the arid region, by natural irrigation districts, to the people of such districts, the whole subject of irrigation to be controlled by

these people under the statutes of the several States and Territories involved. On this subject the Director has a long record, beginning with the publication of his report on the arid lands in 1878. From that time to the present he seems to have consistently recommended the policy which he now urges. While traveling with the committee during the past summer through the arid lands, he carefully and elaborately set forth this plan in many public addresses to constitutional conventions and other bodies of men, and we challenge the production of any paragraph or sentence which the Director has uttered or written, either directly or indirectly, recommending that the works should be constructed by the Government, or that it should interfere with the question of irrigation in any manner except by surveys and by the organization of natural irrigation districts, and by turning over to the farmers of these districts the waters, the forests, and the pasturage, to be protected, controlled, and used under State laws.

SECTION XL.

NO DELAY IN THE OPERATIONS OF THE IRRIGATION SURVEY IS CAUSED BY THE OPERATIONS OF THE GEOLOGICAL SURVEY.

In the report of the majority the following statement appears :

It also prevents the delay which would be occasioned by waiting for the expenditure of many millions of dollars in geologic and topographic surveys and in paleontologic, chemical, and physical researches under the Director of the Geological Survey, and also avoids the embarrassment which would be imposed upon irrigation by charging to it the expenditures made by the Director of the Geological Survey for other purposes.

This paragraph is based upon a misapprehension of facts which it is impossible to explain. It is not proposed by the Director nor by any other person of whom we have knowledge, nor is it contemplated in the existing statutes, that the work of the Irrigation Survey shall wait on the work of the Geological Survey or on paleontologic, chemical, and physical researches carried on in the Geological Survey. The Geological Survey goes on independently of the Irrigation Survey. The Geological Survey will derive great benefit from the Irrigation Survey because the maps constructed for the Irrigation Survey can be used for the Geological Survey. These maps have to be made for geological purposes. They also have to be made for Irrigation Survey purposes, and it matters not to statesmen whether they are made primarily for the one purpose or the other. They must be made for both purposes, and the expense of the topographic work must be provided for from the Treasury, and will be provided even if the Irrigation Survey be discontinued, and there will be no saving to the Government if it is discontinued. We are therefore unable to understand the meaning of these words: "And it also avoids the embarrassment which would be imposed upon irrigation by charging to it the expenditures made by the Director of the Geological Survey for other purposes."

SECTION XLI.

THE EFFECT OF THE ACT OF OCTOBER 2, 1888, ON THE DISPOSAL OF THE PUBLIC DOMAIN IN THE ARID LANDS.

The act creating the Geological Survey, approved March 3, 1879, provided for a classification of the publiclands. It was therefore the basis of the present Irrigation Survey. Under these provisions the irrigable lands, the timber lands, the pasturage lands, the mining lands, and the coal lands were delineated, such being the classes recognized in the

laws relating to the disposal of the public domain by the General Government. March 20, 1888, the following joint resolution enlarging the functions of the Geological Survey was passed :

Whereas a large portion of the unoccupied public lands of the United States is located within what is known as the arid region and now utilized only for grazing purposes, but much of which, by means of irrigation, may be rendered as fertile and productive as any land in the world, capable of supporting a large population, thereby adding to the national wealth and prosperity ;

Whereas all the water flowing during the summer months in many of the streams of the Rocky Mountains, upon which chiefly the husbandman of the plains and the mountain valleys chiefly depends for moisture for his crops, has been appropriated and is used for the irrigation of lands contiguous thereto, whereby a comparatively small area has been reclaimed ; and

Whereas there are many natural depressions near the sources and along the courses of these streams which may be converted into reservoirs for the storage of the surplus water which during the winter and spring seasons flows through the streams ; from which reservoirs the water there stored can be drawn and conducted through properly constructed canals, at the proper season, thus bringing large areas of land into cultivation, and making desirable much of the public land for which there is now no demand ; therefore be it

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior by means of the Director of the Geological Survey be, and he is hereby, directed to make an examination of that portion of the arid regions of the United States where agriculture is carried on by means of irrigation, as to the natural advantages for the storage of water for irrigating purposes with the practicability of constructing reservoirs, together with the capacity of the streams and the cost of construction and capacity of reservoirs, and such other facts as bear on the question of storage of water for irrigating purposes ; and that he be further directed to report to Congress as soon as practicable the result of such investigation.

Again, on October 2, 1888, the following act was passed, in a clause of the sundry civil appropriation bill :

For the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation, and the segregation of the irrigable lands in such arid region, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and the prevention of floods and overflows, and to make the necessary maps, including the pay of employees in field and in office, the cost of all instruments, apparatus, and materials, and all other necessary expenses connected therewith, the work to be performed by the Geological Survey, under the direction of the Secretary of the Interior, the sum of one hundred thousand dollars or so much thereof as may be necessary. And the Director of the Geological Survey under the supervision of the Secretary of the Interior shall make a report to Congress on the first Monday in December of each year, showing in detail how the said money has been expended, the amount used for actual survey and engineer work in the field in locating sites for reservoirs and an itemized account of the expenditures under this appropriation. And all the lands which may hereafter be designated or selected by such United States surveys for sites for reservoirs, ditches or canals for irrigation purposes and all the lands made susceptible of irrigation by such reservoirs, ditches or canals are from this time henceforth hereby reserved from sale as the property of the United States, and shall not be subject after the passage of this act, to entry, settlement or occupation until further provided by law :

Provided, That the President may at any time in his discretion by proclamation open any portion or all of the lands reserved by this provision to settlement under the homestead laws.

The effect of this act was to reserve the sites for irrigating works until Congress should finally decide upon some method of disposing of them to the people. It also required that all lands made susceptible of irrigation should be reserved from disposal by the General Government, except under the terms of the homestead law after proclamation by the President. As the survey was required to present plans for the utilization of all of the stream waters of the arid region and to designate all of the lands susceptible of irrigation by such waters, and to reserve sites for the works and the lands which could be irrigated, the effect was to repeal the desert land law, the timber culture law, and in part

the pre-emption law, and to put all the irrigable lands under the provisions of the homestead law for disposal after proclamation by the President. This effect is produced in the following manner: Those acquiring lands under the desert land act were required to irrigate such lands, but the sites for controlling the waters and the lands that were irrigated were withdrawn from its operations. It was therefore practically repealed. Those acquiring titles to lands under the timber-culture act were required to cultivate timber on such tracts. To do this it is necessary to irrigate them, but as the sites for irrigation works and the lands irrigated were withdrawn from the market, except under the provisions of the homestead law, the timber culture act was practically repealed. In the same manner the pre-emption laws were repealed so far as they applied to irrigable lands, as all lands which could be irrigated by any of the stream waters of the arid region were withdrawn from its operations and placed under the operations of the homestead act only. But there yet remains a method by which timber lands and pasturage lands can be acquired under the provisions of the pre-emption laws. But irrigable lands—actual farming lands—can not thus be acquired. The practical effect of the statute, therefore, is to repeal all methods of disposing of the lands for farming purposes in the arid region except only the method by homestead settlement.

In the Congressional debates which immediately preceded the passage of the act of October 2, 1888, it appears that the purpose of the act was to prevent the monopoly of the sites for irrigating works and of the lands irrigated thereby, and this result is secured by the legislation. The waters on the public domain in the arid region can not now be monopolized by individuals and corporations, and the lands can not be acquired in large bodies as heretofore. This is made more plain when the effect of the desert land laws, timber culture laws, and pre-emption laws, combined with the homestead laws, is fully understood. Under the desert land laws an individual could acquire title to 640 acres, under the timber culture laws to 160 acres, under the pre-emption laws to 160 acres, and under the homestead laws to 160 acres, making in all 1,120 acres. It was thus that large holdings were aggregated. The individuals acquiring titles to large tracts of land in this manner which they could not possibly irrigate with their own means, were compelled to mortgage them, and through the agency of these mortgages the titles of these lands are aggregated in the water and land companies, and in many cases, as has already been shown, the individuals acquiring titles to lands were but the agents of the companies themselves, through which the titles were acquired to be transferred to the great land-holders. The history of the administration of the Land Office for the past eight years is instructive on this point. Sometimes the contracts between the individuals acquiring titles and the companies were so apparently fraudulent that many of these entries have been overthrown; yet probably the greater amount stand.

It is believed that the legislation thus accomplished was wise, and in the interest of homestead settlers on the public domain and opposed to the interests of land and water companies, and we disagree with the majority in recommending its repeal. The proper course now to be pursued by Congress is to complete this legislation by providing means by which the sites for irrigating works selected by the General Government may be turned over to the proper persons—the farmers themselves engaged in agriculture, and the new settlers who are to acquire homesteads. Such additional legislation is incorporated in the bill recommended by the minority. It is also believed to be unwise to dis-

pose of the pasturage lands and timber lands to individuals, but that such lands should remain as permanent reservations in the hands of the General Government, to be used as catchment areas for the waters of irrigation needed on the irrigable lands. Provisions for this purpose have been incorporated in the bill herein recommended. Finally, it is believed to be unwise and unjust to make valid the unlawful claims to sites, waters, and lands which speculators and companies have sought to obtain since the passage of the act of October 2, 1888.

SECTION XLII.

EXPERIMENTAL BORING FOR ARTESIAN WATERS UNWISE.

The majority have formulated another bill, and defend it in their report. This is a bill authorizing the Department of Agriculture to investigate the extent to which artesian and other subterranean waters can be used in irrigating the Great Plains, and already an appropriation of \$20,000 has been made for this purpose on the recommendation of the majority. It is further proposed in this second bill under consideration that an appropriation of \$350,000 shall be made for this purpose. If it is the intention to bore artesian wells to supply the farms of the plains with artesian waters in basins already known, the amount of the appropriation is wholly inadequate. If the appropriation were exhausted in boring wells in artesian basins equal to the average in the world, the area irrigated thereby would be less than three thousand acres. If it is proposed to discover artesian waters in this manner—and that seems to be the correct interpretation—then a geological survey, based upon topography, is necessary, and it should precede all experimental sinking of wells. Perhaps this is the new irrigation survey proposed by the majority, as they appear to deem it unwise to have these investigations relate to any other source of water supply than those mentioned. In fact, it would seem that they expect that the plains can be irrigated by artesian waters. In the United States 8,000,000 acres of land are irrigated by streams, and less than 6,000 acres by artesian wells. There are a thousand artesian wells in Utah, but they irrigate less than 2,000 acres of land, as shown by the printed testimony. No wheat fields, no corn fields, no farms or fields of any character are irrigated from this source anywhere in the United States, or in fact anywhere in the world.

In North and South Dakota there are already many artesian wells, perhaps in the aggregate about 1,000. With four or five exceptions they furnish small amounts of water, and leaving out these phenomenal wells, they would not irrigate 5,000 acres of land if used only during the irrigating season. The non-seasonal flow of these fountains might be stored, and the possible area of irrigation would be increased thereby. But most of these wells are not in the region where irrigation is necessary. The phenomenal wells are in the sub-humid belt where irrigation is needed, and could they be multiplied to a great extent a supply of water would be obtained sufficient to irrigate important tracts of land. Great wells like those at Woonsocket and Aberdeen have been discovered in other regions of the world, but the great flow which they first afforded was not maintained. It has been found by experience that such wells sooner or later exhaust their sources, and that if multiplied the original wells decrease in the volume which they afford. To what extent the artesian formations of the sub humid and arid portions of the Dakotas can be depended upon for a supply of water for

irrigation, is unknown, and can only be revealed by careful geological investigation. This source should not be neglected; it may prove to be of some importance, especially for the irrigation of small tracts. In the sub-humid and arid region of Nebraska, Kansas, and Texas there has also been much experimentation with artesian wells. Most of the experiments have been failures, and the few wells found afford a very small supply of water. The geologists of Kansas and of Texas agree with the Director of the United States Geological Survey that it cannot be expected to obtain any great supply of water for irrigation from these sources.

The people of a portion of North Dakota, South Dakota, and Kansas are suffering great hardship by reason of a famine caused by the lack of rain for the last two or three years. Their farms are burned up, and it is proposed to give them relief by encouraging them to bore for artesian wells and obtain waters for their fields in this manner. But the experience of the world shows that the cost of such waters usually prohibits their use in general agriculture, and that they are used only on lands of great value for the cultivation of gardens, orchards and vineyards, and for domestic purposes. Yet the people in these same regions have a vast source of water in the perennial streams which roll across the plains and in the storm-waters which are gathered on their hills. But the majority practically refuse to have the attention of the farmers called to these great supplies, and are unwilling to have a survey made by which the facts can be demonstrated to the people, lest this vast source of wealth should fall into the hands of the people rather than into the possession of water companies. Shall the people of North and South Dakota, who are now suffering the pangs of famine, be still further deluded, and induced to devote their last energies to search for water where it can not be found in quantities sufficient for their relief, that they may ultimately lose their mortgaged lands and be driven from the country, and that thus new theaters for speculation may be opened when the years of abundant rain-fall come?

The following statement made by Director Powell puts this matter in a clear light. (See pages 87-94 of Vol. IV of the report of the special committee of the Senate.)

Senator CASEY. The one thing we and our people desire to know is, what is the extent of the artesian basin underlying that country; they care nothing for the topography of the country, because their hopes and their courage are dependent on what they ascertain in regard to the water that may be obtained. Now, as this is a question of expense, and the money to be appropriated for the purpose has to be granted by Congress, we want to make the expense involved as trifling as possible until we ascertain those essential facts. Therefore I suggest that perhaps an expensive topographical survey may be dispensed with until we know the facts about the water. Would not that be the better plan? Mr. Chairman, would not that strike you so?

The CHAIRMAN. We will discuss that after hearing all the facts.

Senator CASEY. It was by way of discussing it that I have stated what I have.

Director POWELL. If the artesian waters are to be discovered in such a manner that we may predict something of them—so that we can say to the people, "Bore here and you will get water," or "Do not bore there because you can not get water"—that would be of value. To do that a geological survey based on topography is the cheapest and the quickest method. If we go into that country and write books about guesses as to how the strata lie, about the sandstone and the limestone here and there, without having determined definitely where they lie and at what depth they lie, and as to their character, whether they be pervious or impervious to water, but go in with a general statement to the people that it seems to be a good country for the boring of artesian wells, and if it should afterwards turn out that it is not a good country for that purpose, our reports would be of no practical value. Unless we should be able to say positively "Bore here and you will succeed; if you bore there you will fail," the reports would be of no practical value.

In order to be able to say to the people, "You can do this and you can not do that," you will require a map based on a survey. Geology is expressed in topographic features. The map-making collects and arranges these facts of geology in a manner the most economic. All sound geology is based on topography. No good conclusive geologic work is done in the world without this basis.

The CHAIRMAN. In passing through that section of the country the committee took all the testimony that it could get regarding the condition and the character of the rocks. Suppose now that the United States should make a reasonable appropriation for additional wells to determine the extent of that basin, and an intelligent man, a geologist if you please, were to diligently inquire and make a careful record of what had been discovered—of course your experimental wells would determine in other places—might you not with one or two intelligent men to observe and record what has been done and with the Government making some more wells determine with considerable certainty, so that the people might see where they could sink wells, so as to be making a practical move?

Director POWELL. We can take the artesian basins that we know of. Some of these basins are pretty well discovered and defined, as I have said before. We can say to the people as to certain places, "Bore here" or "Bore there."

There are other places where the artesian basins are not well known, but experiments have been made in them. There are others it is probable now entirely unknown. We know that there are some artesian basins, but we do not know their outlines. One man bores in one place and gets no water. The money of the man who gets no water is therefore lost. To trace the outline of that basin and be able to say to the people "You can bore and get water, but if you bore 1 or 2 miles away you can not get water"—that we can not do until we have studied the geological structure.

The CHAIRMAN. Yes, but that takes a good deal of time. The people are on the ground, and they are boring wells. Their hope is predicated on the prospects of getting water. My idea is to aid them in what they are now doing by collecting the facts as to the penetrations—

Director POWELL. That we are doing.

The CHAIRMAN (continuing). Doing that carefully—ascertaining the levels at which they will have struck water, formulating the information as fast as possible, and giving them all the knowledge available; and then, under an intelligent man, having some Government money expended in boring other wells to relieve them of the experimental expense. I have received I suppose twenty or thirty letters from enterprising men in that section, and one from a gentleman in New York, the other day, who said that he owned some land there and wanted to sell it to settlers. He wanted to know what information there was to be had as to the developments that had been made there in artesian wells, and what the Government could do or would do. It occurred to me that it would be well if you could have somebody who was a good geologist to classify what has been done, without waiting for the topography—without waiting for the general geological survey; simply to classify what well-sinking has been done; and then to let some chances be taken, without speaking with absolute certainty, but giving them all the facts as to where water is found. They will not want to wait until you have done all your work, so as to be able, as you say, to speak positively. They want to do something right away. The people are there and want immediate relief.

Senator CASEY. Will you be able to determine the limits of that basin without the experimentation?

Director POWELL. No, sir; not fully.

Senator CASEY. Is it not better to immediately proceed with the experimentation to ascertain the expanse of those basins instead of waiting for the topographical survey that will involve considerable time and expense? The very fact that the Government is taking an interest in this matter will be of great value to the people of that country. Their courage will be greatly aided. As to a topographical survey, the average citizen knows nothing of it. If he sees a hole being bored in the ground he knows what that means; he knows that it means business. The more important part of the country to water is the uplands, away from the river. What the people desire is that they shall know whether they can have water. Coming over this country, for instance toward the Red River, they will want to know whether they can get water, and at what expense. Can not that be ascertained by experiment, and can not the other work be followed up as inaugurated? That is to say, can not the beginning of the work be the boring of experimental wells?

Director POWELL. The work which is to be done there can be considered from two stand-points. It can be considered from the stand-point of what will be known when it is finished, or it may be considered from the stand-point of its progress—what will be known in the stages of its progress.

While the topographical work is going on, as I should work, the geological work is going on, the experimentation is going on; and the geological work is confirmed

as it is going on, by the experimentation. And when it is finished we will know the whole thing; but we will only know parts, as we finish the work in parts, as we go along. But as we go along the work will be developed *pari passu*.

Senator MOODY. The people who have sunk these wells are not scientific people, but mere well-diggers. The information which they have obtained they have not preserved.

The CHAIRMAN. Some of them have.

Director POWELL. We have more facts than they dream of.

Senator MOODY. They have not the facts which would enable them, or enable a scientific man, to determine the strata and the extent of the basin and all that. Of course you are aware that right here on the banks of the Missouri River, the very southernmost point of South Dakota, they have several wells. We know the fact, of course, that they were obliged to go only from 450 to 650 feet, according to the elevation on which they started, to strike that basin which brings the water to the surface with force, and of course we know the fact, for it is a familiar one, that the pressure there is from 60 to 80 pounds to the square inch. The other day they struck a well at 760 feet at Huron. They had to go 900 feet elsewhere. They got a well at Redfield at about 1,100 feet, and so on. They had to go as far as 1,300 feet on the divide between the Jim River and the Missouri River.

Here is a quartzite stratum along the eastern side of North and South Dakota. That red quartzite which they call jasper, sometimes granite, they have attempted to go through, but they have never found any water at any depth that they have gone through that. So we call that the "rim," or the "rim rock." No experiments have passed over the Missouri River, or over the divide; in fact they have not got quite on the divide.

Now, the query is whether it would not be advisable to put a force into the field at once for the purpose of making a fairly good survey to show what area of this country can be utilized for irrigation—to experiment with this water—to see for example whether there is anything in the water which would be detrimental to crops.

The CHAIRMAN. I think the water is very good.

Senator MOODY. And then to dig experimental wells over west and across along the Missouri. When we get across into the western part of the country we know there is plenty of surface water, and people are using the surface water for irrigation; they are constructing ditches in this region of country. On of these ditches is 25 miles long. But going farther north, into the western part of North Dakota, we do not know how much use can be made of the waters. What we want is that these people already there on the ground—600,000 people are located there—may know where they can get water. The farmers will have to depend upon bringing water to the surface to furnish moisture either in the atmosphere or upon the lands, because there comes sometimes a series of years in which they do not have sufficient rain-fall.

Senator CASEY. And four-fifths of the people are farmers and directly dependent on their farms.

Senator MOODY. Now, as Senator Casey has said, what these people want is courage. The courage of conviction is what they greatly desire, and if the Government will give them sufficient money to dig experimental wells they will take care of the rest.

Senator CASEY. But their courage must be built on that which is palpable to their eyes. They can not be expected to look upon this question from a scientific standpoint at all.

Senator MOODY. They want results.

Director POWELL. But what shall the people be given courage to do, to bore wells where they will ultimately fail? or to bore wells where they will meet with success? Suppose they are advised to bore wells on barren ground; the first failure of that kind would react, and all courage would be lost. I do not wish to give the people courage to lead them on to failure, to waste their energies in seeking disaster.

Senator MOODY. Will not the expenditure of a few thousand dollars there by the Government absolutely determine the question as to where that artesian belt exists and where to bore?

Director POWELL. Artesian water can be discovered in part by experimentation and in part by tracing out the formation of the ground.

Senator MOODY. And one must go with the other, you think, or ought to go with it?

Director POWELL. Yes, precisely. The geological examination without the experimentation will more or less be futile. The experimentation without the geological examination will be wasted. That matter has been up before Congress again and again, and appropriations have been made for Texas and Colorado. Fifty thousand dollars has been expended by the Government and thrown away, and yet there are artesian waters in that State. But the wells were bored without the examination of the geological structure and were not placed where the water was to be found.

Senator MOODY. Is it not practical with a comparatively small appropriation or expenditure for you to put into that country a corps of engineers and others right at once?

Director POWELL. I have estimates sent to the Secretary for each of the Dakotas of \$50,000, with the idea that the work there was pending, that it was necessary, and that they wanted the work done at the earliest possible day.

Senator MOODY. Fifty thousand dollars for each of the Dakotas?

Director POWELL. Yes.

Senator MOODY. Is that enough?

Director POWELL. I have asked for \$50,000 each for North Dakota, South Dakota, Nebraska, Kansas, and Texas, to be used in this work. With that amount of money I propose to take up, first, the study of the artesian waters and storm waters. My judgment is that the storm waters will be most valuable. I want to be frank with you. I think the people are mistaken, but the people believe in the artesian wells and I am going to meet them.

Senator CASEY. And the population lies where the storm water is not available without very great expense, such as the tapping of the Missouri, or something of that kind.

The CHAIRMAN. Oh, no.

Senator CASEY. I am living in that region and am familiar with it.

Director POWELL. My idea is that the people are looking to the artesian waters, and I should push artesian examination first; but I believe that it will be but a small resource, and that the great resource will be in the storm waters and river waters.

Senator CASEY. The experimentation is different in our case, because there are facts that exist from which you may proceed, and the examination of the basin should be from what is known outward.

Director POWELL. Yes; you have artesian basins but how much water will they supply is the vital question.

Senator CASEY. That is a different thing from an examination in a country where no well has ever been discovered.

Director POWELL. Already we have facts in relation to the two Dakotas upon which we can proceed with a great deal of confidence about the artesian waters. There has been sufficient study of the geology and sufficient experimentation to make a basis from which to start.

Senator CASEY. The confidence of the country with regard to the James River Valley itself is established; but the notion exists in the minds of the people that when you have left the particular formation which makes that valley (of which they know nothing, but which they suppose is the formation inclosing the valley) they will not be able to get water. They have not the courage to expend money for wells there. If the Geological Survey will ascertain that the basin is not confined to that particular valley, experiments will go on by the people in all directions, but they must have some one thing to give them that courage.

The CHAIRMAN. Suppose that, taking the places that are known, experimental wells were sunk outside, where the probabilities are great, but where people are not willing to make the experiment, the Government money would not be wasted, would it?

Director POWELL. Some would be wasted and some not.

The CHAIRMAN. If where you succeeded and gave courage then private enterprise would take hold of it; even if you did waste some money the information would be valuable. By sinking the well the formation would be discovered as you went down. What would be the average cost of these wells?

Senator MOODY. The well at Redfield, complete, 1,050 feet in depth, cost \$3,100.

The CHAIRMAN. What did the well at Huron cost?

Senator MOODY. That will cost more, although it is not quite so deep.

Senator CASEY. That well at Jamestown cost \$7,000. But there is nobody who knows just what a well is going to cost.

The CHAIRMAN. I should like to get at a general average, to see how much money is necessary to accomplish any useful purpose.

Senator MOODY. Mr. Holt, whom you met at Huron, I suppose, gave the matter a great deal of attention, from the fact that he has had the management of a farm mortgage company there. He told me that they had received an offer from a responsible company to sink thirty-five wells in that region of country for \$35,000.

The CHAIRMAN. What would be the average depth of those wells?

Senator MOODY. The average depth would be about 800 feet.

The CHAIRMAN. If they went to the higher lands they would have to dig deeper wells?

Senator CASEY. That would be relatively more expensive. I saw Mr. Holt and other people at Huron quite late in the season, and the people on the ground were

quite doubtful as to whether it could be done at that price. So that I think that you will need to reckon on these wells costing \$5,000 each, taking the average of the country up and down.

Senator MOODY. Possibly, if you reckon on the divide, that may be so.

The CHAIRMAN. Major Powell has got \$250,000 for the plains.

Director POWELL. Yes; if the work is to proceed on the theory that the basins are to be discovered by the boring of wells, then the appropriation should be larger. If you want immediate results and want to proceed on the theory that the investigation must be made by experimentation, the appropriation should be larger and it should be expected that much of it would be wasted.

Senator CASEY. That could not be avoided.

Director POWELL. With that understanding we can go ahead experimenting.

Senator MOODY. If every experiment was to be a success we would not want you to make any experiment. We would make it ourselves. It is for the very purpose of determining absolutely that it is no longer an experiment that we want this done.

The CHAIRMAN. The situation out there is very pressing.

Director POWELL. If you will give me sufficient money, I can, within one year, put a corps of geologists and engineers boring on the plains, but it must be understood that much would be wasted, and when the work is finished not a very great supply for agricultural purposes will be given. The amount of water to be obtained from artesian wells is very small, but what there is will be of value.

Senator MOODY. That is what we want.

Senator CASEY. That is what we want so far as North Dakota is concerned.

Director POWELL. Many of the wells bored would be failures; others would be successes. A double corps would be needed—a corps of engineers and a corps of geologists.

The CHAIRMAN. There is a vast population there now that are suffering, and the Government can afford to give them courage, if it is possible to do so. If it could relieve them at once and stop their sufferings it would be a great blessing to that country, for it is really suffering. There are 600,000 people there and they have lost their courage. They want immediate knowledge in order to give them courage. They are a vigorous and active people and only want encouragement.

Senator CASEY. They want the knowledge that the Government is taking an interest in this matter. They want it in a palpable form.

Senator MOODY. Of course we know the existence of this rim-rock. I believe you call it Sioux quartzite?

Director POWELL. Yes.

Senator MOODY. It is a formation by itself. Of course we know there is a little outcrop of that quartzite on the Jim River, which is not very material, and there is nothing of it as you go west. The limit of this artesian basin west has never been found. In other words, it has never been a total failure to find the artesian basin. So we think, or at least we hope, that the proper investigation by scientific men—by the men that you will be able to send out—would supply sufficient facts, so that it would hardly be an experiment to dig a well.

The CHAIRMAN. How much of an examination would it be necessary to make to examine the Missouri River as to where it could be taken out, etc.?

Director POWELL. If any ordinary appropriation is made we will be able to do that next year.

The CHAIRMAN. I do not mean a general survey, but to ascertain the particulars?

Director POWELL. I understand. The single fact could be determined easily; it is a question of levels.

Senator MOODY. The situation of the country is such, that after getting out of the influence of the Jim River you have to take the water from the Missouri. You can not climb this ridge.

The CHAIRMAN. Oh, no. That is the thing we want investigated.

Senator CASEY. The bulk of the population of North Dakota lies east of what is known as the Coteaux.

The CHAIRMAN. Are you through with your general statement, Major Powell?

Director POWELL. Let me say just one word more, Mr. Chairman. If I beg for thorough work, which will not ultimately lead to disappointment, I want you to understand my motive in the matter. We can do work that will be valuable to the people at once, in some cases, but in many cases it would bring disappointment. If we are hurried in doing it, instead of doing it in a careful, scientific manner, many people will fail and will say, "We have failed because we followed the recommendations that were given." We know of three artesian basins in the Dakotas: That on the Red River has been carefully surveyed. Its supply of water is limited; but it is in a region of country where irrigation is not necessary. Farther west there are two other basins, imperfectly known; one of them gives no evidence of being of great value; the other gives evidence of being one of the finest basins in the world and is worthy of the most thorough examination; and yet we can not hope for a great sup-

ply of water for irrigation from it. Water for towns, villages, gardens, ranches, and even for powers, may be obtained, and perhaps some small amount of water for farming purposes; but artesian waters are always limited, and excessive boring destroys them. The great basin of the Dakotas should be utilized to its fullest extent, but it must not be tapped beyond that or the whole thing will collapse. That has been the experience of many artesian basins; and it seems to me that it would be wise to direct the attention of the people more to the storage of storm waters. There are many portions of the Dakotas where this can be done advantageously and cheaply. Yet I do not wish to discourage the use of artesian waters to the utmost extent of the supply.

The principal supply of artesian waters in the two Dakotas is from the Dakota sandstone. All the great wells are found in it. We do not have to discover that sandstone; we know its extent throughout the country, but we do not know how much water it will yield. We do know that the supply is limited, that it can not be great; that it will be impossible to multiply wells indefinitely; and we do not know but that this source has been drawn upon nearly to its limit. Should I say to the people that this sandstone is found from north to south throughout the Dakotas and from the ninety-seventh meridian westward nearly to the Rocky Mountains, and that you can in most places find artesian waters in it—which is a fact—it would give the people courage to bore, and many wells would be immediately sunk, and the probabilities are that the supply would soon become exhausted and all existing wells destroyed. What we want to know is to what extent this source can be drawn upon and when the boring of wells into it must be stopped. But what is still more important, we wish to discover whether there are any other water-bearing formations. All this can be determined in the most speedy and most economical manner by a geological survey based on topography and by an occasional experiment to verify the inferences of the geologist. The geologist is able to say that such and such rocks and such and such districts will not afford artesian waters. His first conclusions are therefore negative, excluding certain rocks and certain districts. Then he discovers other districts where the character of the rocks and the geological structure give probabilities that artesian waters may be found, and these probabilities must be tested by experimentation.

And finally, Mr. Chairman, I wish to be understood as expressing the opinion that when all the artesian waters are discovered and all utilized, there will still not be a sufficient amount of water for the region of country of which we have been talking, extending along the plains from our northern to our southern boundary, greatly to affect the industries of agriculture. Artesian waters have always been and must be inadequate to meet the wants of irrigation, except here and there for gardens, orchards, vineyards, and for stock purposes. The great fields of Dakota can never be cultivated by artesian waters. To encourage the hope for success in this direction, on any scale adequate to the needs, is to give the people a false hope that will lead them to disaster. I know that the people see streams of water bursting out of the ground here and there, impelled high into the air, and in times of drought these are beautiful scenes. I know that they have reached the conclusion that there is a lake of water underground, and that rivers flow beneath their feet, and that they have but to tap these sources to receive an abundant supply. But I also know that these opinions are groundless; that the waters which they obtain are only those which percolate through porous sandstone from a long distance away, and that the supply is exceedingly limited. I know that the sandstone in which it is found is widely spread, but I dare not tell them of its extent lest they be tempted thereby to spend vast sums of money in vain, and reach still worse results by destroying the fountains already developed. It is my opinion that the resource is not exhausted, that some more wells can yet be successfully sunk into the Dakota sandstone, but to what extent it is safe to go on as they have begun I dare not say until a proper examination is made. I am not willing to deliberately face the facts before me and encourage the people as you desire. Is it wise to encourage the people to gamble for water with the dice loaded against them?

JOHN A. REAGAN.
A. P. GORMAN.
JAMES K. JONES.

A BILL to provide for the irrigation of the arid lands of the United States, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior, through the agency of the Irrigation Survey, shall cause the arid lands of the United States to be topographically surveyed and platted into irrigation districts by hydrographic basins, so that one hydrographic system, embracing all of the interdependent waters and lands in relation to irrigation, forest protection, and pasturage protection, shall be included in each, in manner to wit:

First. Wherever it is possible, each irrigation district shall consist of the area drained by the headwaters of a great river, or by one small river and its tributaries, or by a large creek and its tributaries, and it shall include all the lands embraced therein and that are or can be irrigated thereby, and all such headwater districts shall be known as irrigation districts of the first class.

Second. Wherever it is possible, all other lands not included in any irrigation district of the first class, and that lie along any river and belong to the hydrographic basin of such river, shall be divided into districts in such a manner that each district shall embrace all of the irrigable lands belonging to one irrigation system, dependent upon one system of head-works and canals, together with all other lands of whatever nature belonging to the drainage of that portion of the river embraced in said district; and this shall be done in such a manner in each case that the sites for the diverting dam or dams, reservoir or reservoirs, and other head-works, together with the main canal or canals, and all branches thereof, and the section of the river along which it lies on one or both sides, and all lands drained into the river along such section on one or both sides, as the case may be, not embraced in any irrigation district of the first class, and forming the catchment area of such district, shall be included within said irrigation district; and such districts shall be known as irrigation districts of the second class.

Third. That wherever creeks drain contiguous areas and run into valleys or plains, where they disappear or are lost by being discharged into the sands, and thus do not have natural outlets into other streams, they may be thrown by groups of contiguous basins into irrigation districts, or may be attached to other irrigation districts and form constituent parts thereof for the purposes contemplated in this act; and such districts, constituted solely of isolated drainage basins, shall be known as irrigation districts of the third class.

And the boundary of each district shall be determined, with all its meanders, and marked upon the ground; and the topography of each irrigation district shall also be determined by surveys, and maps shall be constructed of the same, appropriately representing such boundaries and such topography.

SEC. 2. That it shall be the duty of the officers of the United States Irrigation Survey to select, define in land-office terms, and designate on the maps the irrigable lands in the irrigation districts provided for in this act; and the lands selected shall be such as can be irrigated by the canals and irrigating works planned and reported by the survey and by the irrigating works already constructed and used for that purpose; and wherever in any topographic basin there is a greater area of good and available irrigable lands than the waters are competent to serve, the lands most favorably situate for irrigation shall be selected, as governed by the following conditions, to wit:

First. The conditions necessary to secure the greatest area of irrigable land.

Second. The conditions necessary to secure the most valuable lands for agricultural purposes by reason of climate.

Third. The conditions necessary to secure the most valuable agricultural lands as determined by soil and subsoil.

Fourth. The conditions necessary to secure lands that can be irrigated and cultivated with the greatest economy.

SEC. 3. That all lands which were irrigated in any irrigation district provided for in this act prior to the passage of the act of October second, eighteen hundred and eighty-eight, providing for the segregation of irrigable lands, and all lands for which irrigation works had been constructed, in whole or in part, prior to the passage of said act, are hereby declared irrigable lands for all purposes contemplated in this act; but this provision shall not be construed to authorize the use of any water for irrigation not legally appropriated; and all lands designated by the United States surveys as irrigable lands, whether belonging to the United States or to other parties, are hereby declared irrigable lands for the purposes contemplated in this act.

SEC. 4. That it shall be the duty of the United States Irrigation Survey to designate the trunk sections of the rivers and large creeks of the irrigation districts, and to determine and locate the places on such trunk sections where dams for irrigating canals may be constructed, and the sites within such irrigation districts which may be used for irrigating reservoirs, and the routes which may be followed for the construction of canals taking water from such designated trunk sections, all in such a

manner as to protect the water rights of the several irrigation districts and to prevent the construction of improvident and obstructive works of irrigation; and it shall be unlawful for any person or corporation to construct, in any of the irrigation districts provided for in this act, any dam, reservoir, canal, or other hydraulic work for irrigation purposes taking water from designated trunk sections upon any site or route not selected and designated by the United States Irrigation Survey for such purposes.

SEC. 5. That all running waters, perennial or intermittent, in the irrigation districts provided for in this act, shall be divided among such irrigation districts in the following manner, to wit:

First. In any irrigation district of the first class all of the waters running therein may be used for irrigation on the lands designated as irrigable lands, and on the lands of town sites; but waters shall not be used for irrigation on the lands of such irrigation districts not thus designated as irrigable lands, or which are not town-site lands; and waters shall not be taken from designated trunk sections except at such places as are designated for that purpose by the United States Irrigation Survey.

Second. In any irrigation district of the second class all of the waters falling thereon may be used for irrigation on the designated irrigable lands and on the town-site lands, and all the waters running in the trunk sections of such irrigation districts may be used on the designated irrigable lands and on the town-site lands; but waters shall not be used for irrigation on the lands of such irrigation districts not thus designated as irrigable lands and town-site lands; and waters shall not be taken from such trunk sections except at the places designated for that purpose by the United States Irrigation Survey.

Third. In any irrigation district of the third class all of the waters falling on or flowing in such irrigation district may be used for irrigation on the designated irrigable lands and on town-site lands; but waters shall not be used for irrigation on the lands of such irrigation district not thus designated as irrigable lands and town-site lands; and waters shall not be taken from designated trunk sections except at such places as are designated for that purpose by the United States Irrigation Survey.

SEC. 6. That whenever a catchment area, in whole or in part, or the reservoir or reservoirs, dam or dams, or other head-works or canals of any irrigation district, as planned by the United States Irrigation Survey, lie within the boundaries of another State or Territory than that to which the chief body of irrigable lands belong, the people of the irrigation district whose lands are irrigated thereby shall have the right to enter-upon the lands where such waters, sites, and works are situate, for the purpose of constructing, maintaining, and protecting the same, and for the purpose of protecting and using the forests and the pasturage thereon; and it shall be unlawful to levy any tax on, or establish any obstruction to the use of, such waters and such forests and pasturage by the State or Territory wherein they are situate; but the jurisdiction over such waters, sites, and works, for the purposes contemplated in this act, shall belong to the irrigation district owning and using the same: *Provided*, That the State or Territory wherein they are situate shall consent to the same as hereinafter provided.

SEC. 7. That all the lands belonging to the United States in any of the irrigation districts provided for in section one of this act shall remain the property of the United States, except as herein provided, to wit:

First. Any lands designated and segregated by the United States surveys as irrigable lands may be acquired by individuals in tracts not greater than eighty acres under the provisions of the United States statutes for the acquirement of homesteads.

Second. Any mining lands in such irrigation districts may be acquired by individuals under the statutes of the United States providing for the acquirement of such mining lands.

Third. Any coal lands lying within such irrigation districts may be acquired by individuals under the statutes of the United States providing for the acquirement of such coal lands.

Fourth. Any town sites that may be selected in such irrigation districts may be acquired by the proper persons under the United States statutes providing for the acquirement of town sites.

All other lands in the irrigation districts are hereby declared to be public lands, to remain the property of the United States, and to be held for the use and benefit of the people of the irrigation districts as forest lands and as pasturage lands, and as catchment areas or sources of supply for the waters to be used in the irrigation district for irrigation and for other beneficial purposes; and such forests and such pasturage may be used by the people of such irrigation districts under the conditions and restrictions hereinafter provided; and all sites for reservoirs, canals, dams, and other hydraulic works designed for irrigating purposes which may be selected by the United States Irrigation Survey shall remain the property of the United States, to be used by the people of such irrigation districts, under the conditions and restrictions hereinafter provided.

SEC. 8. That the owner of any tract of land designated as irrigable land, acquired by homestead settlement, with title inchoate or perfected, or the owner of any tract of land designated as irrigable land acquired in any other manner, shall have the right to use any waters for irrigation belonging to the irrigation district in which his tract of land is situate not otherwise used and appropriated, and shall have the right to be served from any irrigating canal properly located for that purpose by the payment of the proper part of the cost of the construction of the irrigating works upon which his supply of water is dependent, such amount to be determined by the commissioners of the irrigation district who are hereinafter provided for, in compliance with the statutes of the State or Territory to which such irrigation district belongs: *Provided*, That such payment may be extended over a term of years at the discretion of said commissioners, or under the provisions of State or Territorial law.

SEC. 9. That it shall be unlawful for any person or corporation to construct dams, reservoirs, canals, or other hydraulic works for irrigation purposes in the irrigation districts provided for in this act, except such as are authorized by the commissioners of the irrigation district, in conformity with the general statutes of the State or Territory in which the irrigation district is situate and in conformity with the laws of the United States; and no person or corporation shall acquire the right to appropriate and use water for irrigation in any of said irrigation districts except as provided in this act.

SEC. 10. That it shall be lawful for the qualified voters of any irrigation district, as provided in section one of this act, to organize themselves into a body corporate and politic, with powers to sue and be sued, and right to use a seal, for the purposes contemplated in this act, by providing:

First. For a board of irrigation district commissioners of not less than five persons, who shall be elected by the qualified voters of the irrigation district, and who shall constitute the legislative body of the irrigation district to enact laws and rules relating to the use of the waters of the district for irrigation and other purposes, and relating to the use and protection of the timber and fire-wood of the district, and relating to the use and protection of the common pasturage of the district, subject to and in compliance with the statutes of the State or Territory in which such irrigation district is situate and in conformity with the laws of the United States.

Second. For an irrigation court to adjudicate questions that may arise under the laws and rules of the irrigation district relating to the use and distribution of the waters of the district, the protection and use of the timber and fire-wood of the irrigation district, and the use and protection of the pasturage of the irrigation district, and to provide for appeals from such irrigation court to higher courts of the State or Territory.

Third. For a superintendent of irrigation, and for the necessary assistants, as engineers and water-masters.

Fourth. For a superintendent of forestry, and for the necessary assistants, as foresters.

Fifth. For a superintendent of pasturage, and for the necessary assistants, as herders, should they be deemed necessary.

SEC. 11. That it shall be lawful for the commissioners of each irrigation district to provide laws and rules for purposes, to wit:

First. For the use of all the waters falling within the catchment area of the irrigation district, for the irrigation of the lands of the irrigation district, and for other useful and beneficial purposes, and for the recovery, by drainage and other hydraulic methods, of all the waters used in irrigation, and for other public purposes, and for determining how and where they may be reused within the irrigation district on the lands designated as irrigable by the United States Irrigation Survey: *Provided*, That such regulations shall be in conformity with the general statutes of the State or Territory in which the irrigation district is situate and in conformity with the laws of the United States.

Second. For the use and protection of the timber and fire-wood of the irrigation district, in conformity with the general statutes of the State or Territory in which it is situate and in conformity with the laws of the United States.

Third. For the use and protection of the pasturage of the irrigation district, in conformity with the general statutes of the State or Territory in which it is situate and in conformity with the laws of the United States.

SEC. 12. That it shall be lawful for any State or Territory in which are situate any of the irrigation districts authorized in this act to provide by general statute for the purposes herein named, to wit:

First. For the use of the waters of such irrigation districts for service on the lands selected and segregated as irrigable lands by the United States, and for other useful and beneficial purposes; and, further, for the construction of irrigating works under authority of the commissioners of the several irrigation districts by any of the methods, to wit: First, by the co-operation of the people interested therein; second, by taxes levied on the lands irrigated; third, by the issuance of irrigation-district bonds,

the interest and principal to be paid by taxes levied on the land irrigated; fourth, by granting to persons or corporations the right and imposing on them the duty of supplying water for irrigation and other beneficial purposes, through the agency of irrigation works, for a term of twenty-seven years, and by providing that the services of such persons or corporations shall be paid for by the users of the water at just and reasonable rates for measured quantities of water, and not at rates per acre or quantity of land irrigated, and by further providing that at the expiration of twenty-seven years from the beginning of the first service of water, the rights and duties of such persons or corporations shall terminate, and all such irrigation works shall thereupon become and be the property of the irrigation districts to which they pertain.

Second. For the use of the timber and fire-wood of such irrigation districts for domestic, mining, and other purposes, and that the users of timber and wood for such purposes shall pay to the commissioners of any irrigation district from which timber or fire-wood is taken an amount sufficient to cover the expense of the maintenance of the forestry organization in such irrigation district, and not more than twenty per centum of the same added thereto; and all revenue derived from the sale of timber and fire-wood by the commissioners of any irrigation district shall be used, first, for the maintenance of the forestry organization of the irrigation district; and, second, for the construction and maintenance of irrigation works. And the forest areas from which such timber and fire-wood are taken shall be designated by the commissioners of the irrigation districts in such manner as they may deem wise for the protection and advantage of the sources of the water supply for irrigation, and for the protection and permanence of reservoirs and other works of irrigation: *Provided*, That the administration of such statutes shall be relegated to the irrigation districts.

Third. For the use and protection of the pasturage of such irrigation districts: *Provided*, That the administration of such statutes shall be relegated to the irrigation districts.

Sec. 13. That it shall be lawful for any State or Territory in which are situate any of the irrigation districts provided for in this act to provide by statutes for the organization of a State or Territorial board of irrigation commissioners, to consist of not less than five persons, for the purpose of supervising and approving all contracts made by the irrigation-district commissioners for the construction and maintenance of irrigation works, when provision is made to pay for such works by the issue of irrigation-district bonds, or when contracts are made with persons or corporations for the construction and maintenance of irrigation works for a term of years, and such contracts or bonds shall not be valid without the approval of the State or Territorial board; and it shall be the duty of said State or Territorial board to disapprove said contracts or bonds whenever it shall appear that the amount stipulated to be paid by the irrigation district for the construction of irrigation works is excessive and more than sufficient for the economic construction of such irrigation works, or when such works are not properly planned to serve the purposes for which they are intended, or when proper provision is not made for the prompt and complete payment of the interest and principal on bonds or other obligations of the irrigation district.

Sec. 14. That it shall be lawful for any State or Territory to define the boundaries of any city or town in such State or Territory, and to designate the waters to be used in such city or town for domestic, horticultural, and other purposes, but not for agricultural purposes, and to exclude such cities or towns and such waters from the irrigation districts and from the operations of this act, and to regulate by general statutes the conditions under which waters may be used on town sites segregated from the public lands or laid out on other lands.

Sec. 15. That the provisions of this act relating to the organization of the irrigation districts as expressed in sections ten, eleven, twelve, and thirteen shall have no force or effect, and the benefits and privileges of the act relating to sites for reservoirs, dams, canals, and other hydraulic works for irrigation purposes, and to the protection and use of timber and fire-wood, and to the protection and use of pasturage shall not accrue in any State or Territory until such State or Territory shall have performed the followings acts, to wit:

First. It shall be incumbent upon such State or Territory to provide by general statute for the organization of such irrigation districts by the election of commissioners, and for the organization of irrigation courts, and for the election or appointment of a superintendent of irrigation and water-masters, a superintendent of forestry and foresters, and a superintendent of pasturage, in compliance with the provisions of this act.

Second. It shall be incumbent upon such State or Territory to provide by general statute for the use of waters for irrigation and other purposes, relegating its administration to the several irrigation districts, and such statute must be in conformity with the provisions of this act.

Third. It shall be incumbent upon such State or Territory to provide by general statute for the use and protection of timber and fire-wood, relegating its administration to the several irrigation districts, and such statute must be in conformity with the provisions of this act.

Fourth. It shall be incumbent upon such State or Territory to provide by general statute for regulating the use and protection of pasturage, relegating its administration to the several irrigation districts, and such statute must be in conformity with the provisions of this act.

Fifth. It shall be incumbent upon such State or Territory to provide by general statute for the condemnation, relocation, or re-adjustment of improvident or obstructive water rights whenever any water right is declared improvident or obstructive by the commissioners of any irrigation district, and such statute must be in conformity with the provisions of this act.

Sixth. It shall be incumbent upon such State or Territory, by joint resolution of both branches of its legislature, to grant the rights and accept the duties conveyed and intrusted by this act; and whenever the governor of any such State or Territory shall have submitted to the President of the United States such joint resolutions and such general statutes as are nominated in and required by this act, then, if the President of the United States shall find that the requirements of this act are fully and properly met, he may make, and is hereby authorized to make, his proclamation setting forth the fact that the requirements of this act have been properly fulfilled by such State or Territory, and that the several irrigation districts therein are authorized to proceed with their organization, and are entitled to all the rights and subject to all the duties expressed and implied in this act, and thereupon the provisions of this act embraced in sections ten, eleven, twelve, and thirteen shall have force and effect as law.

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51ST CONGRESS, }
1st Session. }

SENATE.

{ REPORT 928,
Part 2. }

REPORT
OF THE
SPECIAL COMMITTEE
OF THE
UNITED STATES SENATE
ON THE
IRRIGATION AND RECLAMATION OF ARID LANDS.

VOL. I.—THE NORTHWEST.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1890.

VOL. I.

THE NORTHWEST.

SOUTH DAKOTA.

NORTH DAKOTA.

MONTANA.

EASTERN WASHINGTON.

EASTERN OREGON.

IDAHO.

IRRIGATION AND RECLAMATION OF ARID LANDS.

WASHINGTON, D. C., April 8, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), Allison, Hiscock, Plumb, Gorman, Jones of Arkansas, and Reagan.

The resolutions forming the committee and prescribing its functions were read, as follows:

IN THE SENATE OF THE UNITED STATES,
February 14, 1889.

Resolved, That a select committee of seven Senators be appointed by the President of the Senate, to be known as the Select Committee on Irrigation and Reclamation of Arid Lands, whose duty it shall be to consider the subject of irrigation and the best mode of reclaiming the arid lands of the United States, and that said committee shall have leave to sit during the recess of the Senate, and shall report to the Senate at the meeting of Congress in December next what legislation is necessary for such irrigation and reclamation; and the committee may employ a clerk who shall be paid six dollars per diem out of the contingent fund of the Senate.

Under the foregoing resolution the President *pro tempore* appointed Senators Stewart, Allison, Plumb, Hiscock, Gorman, Reagan, and Jones of Arkansas.

IN THE SENATE OF THE UNITED STATES,
February 25, 1889.

Resolved, That the Select Committee on Irrigation and Reclamation of Arid Lands, appointed under authority of a resolution of the Senate of February 14, 1889, is hereby authorized in pursuing the investigation in said resolution ordered, to hold its session and to take testimony at any place in the United States, and to employ a stenographer and a messenger; the expenses of such investigation to be paid from the contingent fund of the Senate. The committee is also authorized to cause its proceedings and the testimony taken before it to be printed from time to time as it may see fit, exclusively for its use. Any subcommittee appointed by said committee may exercise the same powers as the full committee.

On motion of Senator Hiscock, the committee adjourned to meet at St. Paul, Minn., August 1, 1889.

THE TWO DAKOTAS.

ST. PAUL, MINN., *August 1, 1889.*

The committee met pursuant to adjournment.

Present: Messrs. Stewart (chairman) and Reagan; also, by invitation of the committee to take part in its proceedings, Director J. W. Powell, of the Geological Survey.

The CHAIRMAN. The committee meets here for the purpose of hearing what the delegation from Dakota may have to say with regard to that country.

The object of the investigations to be made by this committee is the ascertainment of facts touching the peculiar conditions of the different sections of the arid country, with a view to legislation in the future. As there are several gentlemen here from different parts of Dakota we would like to have each one of them, or as many as may be able, to speak with reference to their localities; stating what water-supply facilities they have; what is the general topography of their sections; what they have done in the way of irrigation, and what is the necessity for it, giving their reasons therefor.

REMARKS OF E. V. SMALLEY, OF ST. PAUL, MINN.

Mr. Chairman and gentlemen, the chairman of our Chamber of Commerce, Mr. Bishop, was not able to be here this morning, and he has directed me to offer to the committee the use of this chamber, as has been already done by the secretary, and to express to you in a few words the very cordial interest we feel here in St. Paul in the work of this committee. It was with great satisfaction we learned that you had selected this city for the place of your first meeting and point of departure through the West.

St. Paul's trade relations extend over the whole northern part of what is known as the arid belt; that is to say, we have a direct interest in the development of the entire region from here to the Pacific coast, a great part of which will be the scene of your labors and researches.

Fortunately our own State of Minnesota is not in need of irrigation, and heretofore we have never regarded Dakota as a region where irrigation was essential to the production of crops. But in recent years, as these gentlemen from that region will tell you, a sentiment has grown up there, through necessity, in favor of increasing its water supply by means of artesian wells.

When you get west of Dakota you come to Montana, which is entirely a region where the rain-fall must be supplemented by irrigation, if successful farming is to be carried on. Beyond that the whole of the

Territory of Idaho, which we also regard as within our trade region, must be classed as a country suitable for irrigation, with a considerable portion also of Washington Territory.

Now, gentlemen, I shall detain you only to say that in the development of this country St. Paul has a great and growing interest, and we desire also, when we can, to second your labors and to assure you of our hearty interest in them. It was with pleasure we heard that the National Government had taken up this work of inquiry by the appointment of a committee so thoroughly competent to deal with the subject, and we trust that something more may come out of its labors than the preparation of a report. We have hope that the gentlemen of this committee will second the efforts of the people in these new States, and that the General Government will give to that people some model systems of irrigation; that they may show what it is possible to do on a large scale with some of the great rivers that now run waste to the sea.

STATEMENT OF A. W. BURT, OF HURON, BEADLE COUNTY, DAKOTA.

Mr. Chairman and gentlemen, I appear before you as a representative of Beadle County, in central Dakota, having been sent here by the county commissioners of that county to present to you the question of sinking artesian wells for the purposes of irrigation. That question is one of great importance to the people of Dakota.

I first went to Dakota in the fall of 1881, and moved there to live in the spring of 1882. At that time there was little or no settlement in that country.

During the winter of 1880 and 1881 there was in that country what might be called abnormal snow—an extraordinary deposit of snow. That snow melted and filled all the lake beds and low places with water. During the summer of 1882 we had rains frequently—heavy rains. I know that, because I was out on my claim in a tent, and we got wet nearly every day.

Every summer, from May until along in July, we had copious rains, which replenished those low places on the face of the prairie. Then we had plenty of moisture. I was enchanted with the country, because I saw that everything grew luxuriantly. That season what little crops were there, what little matured, were good, and the vegetables of every description grew to mammoth size. We are all well satisfied that the soil of that Territory is very fertile, and that the possibilities of its production has not been ascertained.

In 1883 it was a dryer season, still we had plenty of moisture on the surface and we had good crops. The summer of 1884 came, and it was dryer still; and since that time it has continued to grow dryer until the supply of water which we had obtained in 1881 and 1882 became exhausted.

Thousands of men went into that country in 1882 and 1883 and made their homes there. I had followed a professional life for a good many years, but I sought rest from its exhausting demands, and what wealth I have in all this world is now in farming interests in that country, and what I now tell you I have seen, experienced, and know.

The soil of Dakota is a black soil from 16 to 20 inches thick. Underneath it through that section of the Territory—central Dakota—lies what may be called red clay, hard and almost impervious to water. Therefore, when the water falls upon the surface of the earth it is kept on this subsoil; so that when the rains are over vegetation may draw

from this supply. The only thing is to get the water into the ground. When I went to Dakota artesian wells were not thought of. I think the first discovery made in that direction was by the railroad companies, who dug wells to supply their trains with water.

Mr. Chairman, you say that you wish to know facts. We of Dakota dislike to have our country referred to as an arid country. We have always insisted that we had one of the grandest countries in the world, yet to-day, while still clinging to that belief, we must admit that the farming of that country is substantially reduced to a question of luck. It is this way: In the west or northwest you will see the clouds rise. You have 200 acres lying out. A shower seems to hover in the sky. After two or three seasons you will watch that threatening shower with as strong an interest as you would a little child that might come into danger, in the hope that it may come across your farm and give you water on your wheat. I mention that to show the feeling of every man in that country who has crops in the ground upon which he is relying for subsistence.

The crops that we raise in Dakota are wheat, rye, barley, potatoes, all kinds of vegetables, and oats. We have some snow in the winter time, but we have not had a heavy fall since 1882. The vegetables and grain start well in the spring, because there is sufficient moisture. If in the month of May, after the crops begin to draw on the soil, we could have some moisture to open the land we would not have any fear that we would have perfect crops. So that the application of water to the land at that time of the year would be beneficial to the crops. We often start our plows when the wheat is off the stubble. Last fall the ground was very dry and we plowed it and it lay there, and the wheat and the oats never sprouted during all the fall; but I believe that if artesian-well water or reservoir water could have been put upon that land and allowed to lay on the subsoil during the winter, there would have been sufficient moisture to have perfected the crops of small grain without further assistance.

I am not here to advance theories; I am no civil engineer; I understand nothing about the systems of irrigating, but I will say to you that as you go from Sioux Falls, which I understand you are to visit, up through Huron and Jamestown, on your way westward out of the Sioux Valley on to the table-lands, which you will find lie in long wavy rolls like waves of the sea with high ridges running in various directions, sometimes the points of those ridges coming together, there you will find places for artesian wells from which miles and miles of land may be filled with water.

Senator REAGAN. Be good enough to state to us the extent to which artesian wells have been obtained in Dakota.

Mr. BURT. I was about to proceed to that. In 1885 the city of Huron, which at that time had the Holly water works system of supplying water, came to the conclusion that they would sink an artesian well. They had been induced to do this on account of the well at Miller, 40 miles away, and one at Hitchcock, and another at Groton. The well at Huron was completed in September, 1886. I have here a statement showing the different formations through which the drill passed when that was sunk. It is as follows:

Huron artesian well sunk during the month of September, 1886

	Formation.	Feet.	Depth.
1	Yellow clay	18	18
2	Blue clay	76	89
3	Gray shale	151	240
4	Hard iron rock	2	242
5	Sand	5	247
6	Hard sand rock	2	249
7	Gray shale	175	424
8	Hard sand rock	10	434
9	Gray shale	15	449
10	Brown shale	101	550
11	Sand rock	41	591
12	Gray shale	101	692
13	Brown lime	10	*702
14	Sand rock, white	50	753
15	Hard sand rock	10	763
16	Sand rock, white	40	†803

* This came to cap of water-bearing rock.

† Second flow.

Then went down 61 feet deeper through hard sand rock and gray lime but stopped, as appropriation gave out, and as sufficient water for all purposes was found it was considered wise not to go deeper. The flow of this well is 1,400 gallons per minute. When closed there is a pressure of 170 pounds to the square inch.

ALEX. MCINTOSH,

Water Commissioner, City of Huron.

HURON, DAK., June 13, 1889.

When this well was completed and the water put in motion, confined in the pipe, it went straight out of the pipe into the air nearly 100 feet. The pressure was 170 pounds to the square inch. The water from that well is as clear and pure as the water which flows from the springs in the Vermont hills and mountains. It is wholesome water. I use it in my family, and others do. It takes kindly to vegetation also. I am now using it in town on trees of various kinds, upon white clover, upon red clover, upon timothy and other grass, upon crops and vegetables of various kinds, and even on house plants. Pot plants flourish under its application. The well at Miller, 40 miles west, has a double flow. I do not know the pressure of that well. They have not yet utilized the pressure. The well has been sunk, but they are not running it, because they have not the means to inaugurate a system of water-works.

There is a well 140 miles north of Huron, at Hitchcock, said to have a pressure of 200 pounds. That well runs a grist and feed mill. Besides that they have a lake a little west of the town which at one time was half a mile long and 80 rods wide. That lake afforded a large amount of evaporation and made things look cheerful. A gentleman complained of that lake because a portion of it came on three acres of his land. He commenced suit against the town, he being one of 300,000 in Dakota who objected to water. He enjoined the town from proceeding. I defended the town. Of course I did not suppose he could get more than nominal damages. The result of the suit was that this lake was lowered and the water was turned from this man's land and allowed to proceed in another direction. The farmers on the other side of the town had "caught on," if you will allow the expression, and had the water sent out over their farms. The water runs some 7 miles after having done duty in the grist mill and lands in a little place called Wall Lake, and 30 rods each way from the stream you can see the difference in the grass from that which is beyond that distance.

I wish to mention one thing further in this connection. In the spring of 1882 I went out on my homestead and staid there until I could see growing 100 acres of wheat, which I had assisted with my own hands in putting in. In the spring of 1882 when we went out in the morning to see about our stock or after our oxen and horses we would have to wear rubber boots, because it would wet our leather boots through in a short time. But this summer I venture to say that there has been no morning since the first of July that I could not step out in that grass in my stocking feet and not be seriously inconvenienced.

Our belief in that country is that if we can fill up those ponds and low places with water so that we can have evaporation it will materially help humidity. We believe that if we could have a sufficient number of wells to supply the water we could raise trees without any trouble, because we find the trees grow finely under it. Hundreds of thousands of dollars go East every year for coal which comes to Dakota, goes into the grate, and out of the chimney in smoke with no compensating return from it. It is a dead investment because used for cooking purposes and heat. But send those streams out over those prairies and down those runs, and we could raise trees for our fuel and thus save a heavy drain upon the country.

I am aware that there are a great many theories upon the subject of irrigation. They say that moist winds come from Japan and strike the Rocky Mountains and there become condensed because of the frigidity that is up in those mountains. While it is possible that those vapors and currents of moist air are arrested by that process, still we have some compensating circumstances to consider. The moisture may not come to us in the form of vapor, but may it not come down through the crevices of those rocks and subterranean passages in an inexhaustible supply of water? Whatever may be the theory of those who think that this water may become exhausted, if we can get what is there we would ask that you give us that. We have gone to that country to develop it, to add to the riches of this mighty nation, and we ask that we be properly assisted, that we may be able to raise our wheat and grain in such quantities and at such reasonable prices that no man may have a corner on his neighbor's daily bread.

The CHAIRMAN. To what extent have you explored this artesian belt? How wide apart are your wells at different points?

Mr. BURT. There is one at Miller, 40 miles west; one 20 miles north; two at Aberdeen; one at Groton, and then our well.

The CHAIRMAN. Do these wells of which you speak follow the line of the river, or are they anywhere across the plains?

Mr. BURT. Across the plains. There is one more point, Highmore, which stands upon the Missouri and James River valleys.

The CHAIRMAN. Have not wells been sunk that failed, that did not strike the belt?

Mr. BURT. Not that I know. Over the divide, still going toward the Missouri, there is a flowing well.

The CHAIRMAN. Then, at all points where they have sunk the wells sufficiently deep they have struck water?

Mr. BURT. Yes. So well satisfied are the business men of Huron about water that when they make a contract with any one to sink a well they do not ask about water.

Senator REAGAN. What is the depth of those wells?

Mr. BURT. The well at Highmore is 1,552 feet. That stands upon the summit of the divide between the James and the Missouri River valleys. The depth of our well I have stated. I am not able to give

the depth of the other wells. In order to show the power of this well at Huron, I desire to submit to the committee a photograph taken in July last of the streams of water from the hose used for fire purposes. Upon the back you will find some memoranda which may interest you. I have had hard work many times to convince eastern people that there was not some artificial power behind that water. But this photograph represents the stream as it comes from the bowels of the earth by natural forces. That block [indicating on a photograph] is about three-quarters of a mile from the well. Water is forced through the main. We have never had any trouble about it. There never has been any cessation of that pressure. For one year we kept the fires banked at the Holly water-works for fear that the well might go back on us; but it has never failed, and now we do not watch it.

The CHAIRMAN. Has there been any decrease in the volume of the water from any of those wells?

Mr. BURT. Not that I know. At Aberdeen there are two wells 150 feet apart, and the sinking of one did not affect the other.

The CHAIRMAN. As I understood you in reading the list of the different layers through which the drill passed you gave sandstone as the rock carrying the water.

Mr. BURT. White sandstone.

The CHAIRMAN. Is it all cross-grain?

Mr. BURT. They tell me it is porous like a sponge.

The CHAIRMAN. What was the thickness of that layer? I believe you gave it as some 60 feet, did you not?

Mr. BURT. I do not remember the figures—40 feet, I believe.

The CHAIRMAN. Do you know what was the thickness they met with in that water-bearing rock in the other wells?

Mr. BURT. I do not.

The CHAIRMAN. Whether it maintained a uniform thickness or not?

Mr. BURT. I do not know.

Senator REAGAN. In boring these wells have you come across coal or illuminating gas?

Mr. BURT. As to the coal, we have not. When they drill through this rock it becomes powder, and as it is necessary to fill the hole with water they follow it down with a pipe and work the drill inside, and whatever comes up is ground so fine that unless you are specially looking for coal you would not notice, though you might pass through it. The men who sunk this well were not thinking of coal, only of water, and no observation was made. In this connection I would like to say that if the Government desires knowledge of the geology of that country it could find no better way of ascertaining the formation of that soil than by sinking wells. I believe that it will be discovered in time that coal is in certain portions of that section of the country.

Director POWELL. I believe you have mentioned seven artesian wells in your section of country, the deepest of which is 1,500 feet.

Mr. BURT. That at Highmore is 1,552 feet.

Director POWELL. In what direction is the general drainage at the surface?

Mr. BURT. The general direction of the flow at the surface is on the east side of this divide of which I spoke. There it all flows toward the James River, and on the west towards the Missouri, and there is a general lay of the country sloping in that direction. There are little runs and low places, little hollows that run back into the country 40 or 50 miles and flow down across the prairie, and after awhile they grow deeper and deeper when you come into the vicinity of the river where

all this drainage goes. Those places are innumerable all over that valley.

Director POWELL. The general drainage is eastward into the James River?

Mr. BURT. Yes.

Director POWELL. The deepest well is 1,552 feet, and about 800 feet down near the valley of the James?

Mr. BURT. Eight hundred feet.

STATEMENT OF JOHN R. WILSON, OF DEADWOOD.

Mr. Chairman and gentlemen, it is proper I should say I am not a delegate to this meeting. I am here by courtesy of your committee and of the committee that was sent here by the Farmers' Alliance, of Dakota.

I have here some statements made by responsible parties in the section of the country in which I live. These statements are in the shape of letters, and while only portions of the letters relate to the subject which you are investigating, yet I submit them for your inspection.

I reside in Lawrence County, at Deadwood, in the section known as the Black Hills. It is the area of country lying between the forks of the Cheyenne River, in southwestern Dakota, embracing six or eight million acres of land. It is that portion of the country ceded in the Indian treaty of February 28, 1877. It is a country that up to within the last few years was more widely known for its mining resources than for its agricultural interests. But to-day the agricultural and stock interests of the Black Hills are in the ratio of 4 to 1 of its mining interests.

We have in that section a belt, 156 miles long and from 30 to 40 miles wide, of rough, mountainous country, and that is known as mineral land, yet at the same time is covered by vast forests of pine timber. All through those hills are beautiful parks that are very productive, and that are utilized for agricultural purposes. Generally the rain-fall about the hills has been sufficient for agricultural purposes, and farming has been reasonably so for the home markets.

I desire to submit first some arguments as to the necessity for irrigation in Dakota, and in doing so shall read the statement of a gentleman named Samuel Cushman, an insurance agent, who engaged in leasing on farm lands, he being a resident of Colorado for eighteen years, a gentleman of wide experience and perfectly familiar with the country:

During my residence in Colorado, from 1860 to 1878, I watched the steady and substantial progress of irrigation with more than ordinary interest. Three years ago I had an opportunity of witnessing the remarkable advance in the business since 1878. I was informed in Denver by capitalists that irrigation securities, especially the older ditch companies, that were selling all the water they could furnish, were the best in the market, being regarded as safe, profitable, and likely to be still more profitable. At my last visit to Colorado I saw an uncultivated 160, as dry and barren as in the old days, right in the midst of cultivated and well-watered farms. On the natural ground there was the same old tufts of bunch-grass, 12 to 18 inches apart, and on the bare spaces between the same old cactus was crawling, while just over the fences were the finest crops of clover, alfalfa, timothy, wheat, oats, etc., I ever saw in any country. The change was due to water alone, no manure or fertilizer of any kind being required on that rich soil that lacked nothing but water.

I have been a resident of Deadwood since 1878, and for eight years have been doing insurance, and for the past five have been in the farm-loan business. My business has taken me over a considerable portion of the agricultural country surrounding the Black Hills on the north and east. There are no farming lands in the whole sec-

tion that are not or would not be more valuable for irrigation. Those lying adjacent to the hills receive more showers, and in an average year raise an average crop. Twelve or fifteen miles from the hills the showers are light, and at 25 or 30 miles they amount to nothing. There, on as rich soil as can be found in the world, the crops come forward with the spring showers and rain, and up to the middle of June look well; then they begin to burn up with the drouth and frequently are not worth harvesting. In some of these localities farmers have taken out short ditches, enough to cover a portion of their farms. Crops under the ditches are wonderful and repeat the Colorado experience. I know of no part of Colorado where there is greater need and greater demand for irrigation canals than on each side of the Belle Fourche River. It can not fail, in my judgment, to prove a highly profitable enterprise to take the water of the Red Water and distribute it over the thousands of acres of rich but arid lands lying beneath the canal survey.

Now permit me to call to your attention a map of that country, showing the land that will be open to settlement, the Indians being willing, by the act of the last Congress. [Exhibiting map.] That [indicating] is the land, the part which is colored light. The section of the hills in which I live is the section between the two forks of the Cheyenne River. I am personally acquainted with a great deal of the land lying between the Missouri and the Cheyenne Rivers, and also with that portion of the Indian reservation to be open to settlement and lying north of the Cheyenne River. I see in the hall a resident of St. Paul, Mr. Blakely, who can give you a better description of that land than I can; but, in my judgment, no finer piece of land can exist than that is.

The CHAIRMAN. What are the hopes for obtaining water there?

Mr. WILSON. From my knowledge of the country it is impossible to utilize the Cheyenne River for that purpose. The river there lies deep within its banks, and to construct ditches and dams is impossible. When Major Powell visits that country he may be able to give the committee more information than I can. I simply call it to your attention to show the area of country that can be benefited by irrigation. The General Government owns that land, a large extent of it, and it should make these experiments there. By so doing it will enhance the value of that land very much. Unless something be done to secure irrigation in that country farms there will be valueless.

The Star and Bullock Stock Company owns land lying in the Belle Fourche. The secretary of that company writes:

We have a very great interest in this matter, in that we own over 2,000 acres of land under the line of the proposed ditch and are engaged in farming and stock-raising. A bountiful supply of water is absolutely necessary to the success of our business, and the experience of the past ten years satisfies us that the proposed system of irrigation is essential to the successful cultivation of this entire valley. There can be some 30,000 or 40,000 acres covered by the proposed ditch and a very large portion of this land is of the best quality. In our stock business and the farming operations connected therewith we shall require from 500 to 700 inches of water annually, and there is no question but that with the rapid settlement of this section which will speedily follow the location of this ditch there will be a demand for all the water obtainable and that land values will very greatly increase. Every acre of tillable land that can be irrigated is fairly worth \$10 per acre, and when it is actually covered by the ditch will be readily worth \$20 per acre.

I have a statement here which Major Powell will verify, to the effect that to irrigate an acre of land it requires a foot of water over the land to be irrigated.

The CHAIRMAN. A foot deep is 12 inches deep over the area to be irrigated?

Mr. WILSON. Yes. I will read an extract from a pamphlet prepared by the Arkansas River Land and Canal Company:

Experience proves that the amount of water needed during the cropping season, when irrigation is required, is equivalent to 30 inches deep upon the land if all ap-

plied at once, or that 1 cubic foot per second, flowing night and day for one hundred days, will irrigate 80 acres of land. The well, the wind-mill pump, or even the ever-flowing artesian well, which suggest themselves, are thus seen to be entirely inadequate for even small farming, and the only method is by canals and ditches.

The very high price obtained for garden and field products caused the first settlers to construct ditches that would cover a few farms along the stream, which could be cheaply made. Usually this was done by co-operation, each farmer taking his team and doing a certain portion of the work. The success of these first attempts finally attracted the attention of capitalists, and it was found that the water paid as great a revenue as the land, and the two were necessarily joined.

When the Greeley colonists built their main ditch, a water right for 80 acres of land cost from \$75 to \$100. Now, twelve years later, the same right would sell for more than \$1,000. This right must bear its proportionate share of the expense of superintendence and repairs, usually in smaller ditches of about 40 cents per acre per annum. When capitalists construct the larger canals, covering larger tracts of land, they generally decline to sell water rights, but sell to each farmer what he requires, at a stipulated price per acre for each year. This price has increased gradually ever since the custom has prevailed. One dollar per annum per acre was for a time the usual rental for water; now there are few if any ditches which do not receive \$2, and some even more than that. By the laws of the State the first ditch constructed has a priority to the water appropriated, and no canal tapping the stream nearer its source can divert the water of the older ditch. The laws provide for measurement, proof of quality, and date of appropriation, so that there may be no controversy as to whom the water right fairly belongs. Every equitable safeguard which experience suggests is made to protect the rights of those who invest in these enterprises.

The people of the State are fully alive to the importance of utilizing all the water of the mountains on the farm, in order to be able to supply the home markets, and prevent, as much as possible, the outflow of money for bread-stuffs, vegetables, fruits, etc., which now goes to other States to so large an extent.

In the last three years several very large canals have been constructed, many miles in length, and covering large bodies of land hitherto producing only the meager pasturage of the plains. One of these, which has cost nearly \$1,000,000, will irrigate about 65,000 acres of land. The canal, which is 82 miles long, covers very much more land than it is capable of furnishing water for, and so great is the competition that parties are paying from \$9 to \$25 an acre for the privilege of obtaining water at an annual rental which will probably pay a net interest on the investment of 10 per cent.

I have also a letter from Mr. A. D. McPherson who represents a bank with footings of over \$1,000,000 and a surplus of \$225,000. He says:

Irrigation is just as legitimate as the business of farming itself, inasmuch as its very object is to make the farmer who partakes of its benefits almost absolutely certain of reward for his labor, and to make that reward much greater by greatly increasing the productiveness of his land. Therefore, the irrigating canal is the hand-maid of the farm, and when judiciously used must produce results very beneficial to the owners.

I have been familiar with the tract of country which it is proposed to cover with the irrigating canal under consideration for the past twelve years, and the statements made as to the quantity and quality of the farming land within the area named are fully borne out by the facts.

Mr. Selbie, the cashier of the Merchants' National Bank, writes as follows:

It is proposed to consolidate the present ditches taken from the Red Water and greatly increase their capacity. A large amount of excellent farm land is under these ditches and requires water to make it productive. This district lies outside of the rain belt in the hills, and, without water, is of no value except for pasture; but with water magnificent crops can be raised with certainty.

The area of country spoken of is nearly 1,000,000 acres of land, and there is no water on it except that which flows from the streams in the hills. Reservoirs could be established in the hills so that it might be used later; but where to establish them would have to be determined by surveys, and that can be accomplished only by national aid.

I have also a statement made by a farmer who has worked in the Belle Fourche Valley, and every word stated by him is, to a certain extent,

applicable to that whole extent of country. His statement is in the form of an affidavit, and it is as follows:

TERRITORY OF DAKOTA,
Lawrence County, ss. :

Andrew H. Snyder, being first duly sworn, deposes and says that he resides in the Belle Fourche Valley, in Sec. 14, T. 8 N., of R. 5 E., and has resided there for nearly ten years past; that the land in that valley is of a most desirable character, and when there is plenty of rain produces splendidly; that affiant and his two brothers have 640 acres of land in that vicinity, and are engaged in farming; that they have raised three fair crops out of ten planted, and have done better than most of their neighbors; that if they could have had water for irrigation they would have raised a good crop every year, and in the years that it rained he could have raised much better and heavier crops with irrigation; in this affiant's opinion irrigation is absolutely essential to successful farming in this valley, and that in a very few years nearly every farmer below the ditch would use the water for irrigating. I would consider my land better worth \$20 per acre if covered by water than \$10 as now located; that, in my opinion, there would be a demand for every inch of water that could be brought onto this valley.

Affiant further says that very recently, in connection with his neighbors, he had a survey made for the purpose of locating a ditch and taking water from the Belle Fourche for the purpose of irrigating this section, but found it impracticable to get the water from the Belle Fourche on this valley; but it can very easily be brought from the Redwater; that unless irrigation is arranged for, affiant says he will do but little farming hereafter, and will sell out as soon as possible when he can get his money out of his property; that affiant and his brothers would require irrigation for 300 to 400 acres each year.

ANDREW H. SNYDER.

Subscribed and sworn to before me this 27th day of July, A. D. 1889.

[SEAL.]

S. M. HOUGHTON,
Notary Public.

Here is another affidavit made by a gentleman named A. A. Chouteau, who says:

TERRITORY OF DAKOTA,
County of Lawrence, ss. :

A. A. Chouteau, being first duly sworn, deposes and says that he has been a resident of Butte County, Dak., for the past ten years, and is well acquainted with the lands in the Belle Fourche Valley and surrounding country; that the said valley contains from thirty to forty thousand acres of land which are susceptible of irrigation, and specially adapted for it within a distance of 24 miles eastward from Minnesota; that from his personal observation, extending over a period of ten years, he can state that the farmers who have been able to irrigate their land have uniformly raised large crops every year, and that the others have raised good crops only during the wet years, that is to say, about one year in four; and that even in the wet years the irrigators have produced far larger and better crops than the others; that many farmers have determined to quit trying to raise grain unless there is a prospect for a water canal to be extended to cover their lands. I believe that an extension of the water canal will double the present value of the lands which shall be brought under the canal, because it will insure a large and certain annual crop of all grains and grass, and the crops of all kinds will average more than double the quantity which can be produced without irrigation.

Affiant further states that he is the owner of 500 acres of land under the water canal, and will require between 200 and 250 inches of water, which he intends to purchase from the water company.

A. A. CHOUTEAU.

Subscribed and sworn to before me this 27th day of July, 1889.

[SEAL.]

S. M. HOUGHTON,
Notary Public.

I have one more letter, which I wish to call to your attention, a letter written by a Mr. Martin, of the firm of Martin & Mason, also president of the Merchants' National Bank. He says:

There are thousands of acres of very fertile lands in the Belle Fourche and in the valleys of its tributary streams that require irrigation to secure regular and abundant crops. Without irrigation the lands do not produce good crops, except for an occasional season when the rains chance to be sufficient for the requirements of the soil; and such seasons have been very rare in the past ten years.

This has been attracting the attention not only of the people throughout the hills and the whole country lying west of the Missouri and the hundredth meridian, but it is going east of that; and I have heard Major Powell himself express some surprise to find that the people of eastern Dakota were asking for irrigation and storage. Here let me call the attention of the committee to an article which appears in the Redfield Dispatch. Redfield lies in the eastern portion of Dakota, in a country that was always supposed to have been abundantly supplied with rain. This article is very short and I will read it here.

Though it may not be necessary to irrigate the lands in Dakota every year in order to raise big crops, it has been demonstrated repeatedly that a reasonable amount of rain at a critical period in the growth of wheat and other crops would have doubled the yield, and in some instances turned an absolute failure into a bountiful crop. In view of these facts it is well enough to go about getting the water on hand to use it if it is necessary.

Aberdeen is the next town lying above Redfield; and at Aberdeen they have also an excellent flowing well. The News on the 11th of July had the following, which I read:

S. M. Gibbs, a resident of Riverside Township, was in the city last evening on his way home from an extensive trip through Arizona, New Mexico, Utah, Colorado and southern California. He left Brown County the 1st of June, and has been putting in his time investigating the irrigation system of the above-mentioned States and Territories. A reporter had a few minutes' conversation with Mr. Gibbs, during which the latter was profuse in his expressions of the beneficial results of irrigation and the success sure to attend it if taken up in Dakota. In the sections which he passed through, the water supply comes largely, of course, from rivers and mountain streams, but on several occasions he had opportunity to inspect large tracts of land which were supplied by artesian wells alone and which were practically deserts before reclaimed by means of the moisture drawn from the bowels of the earth. At Riverside, California, he found the main supply came from the wells and the Gage system of water works, and here the results had been simply magnificent.

Whenever he had opportunity Mr. Gibbs consulted with practical engineers with reference to this work in Dakota: Their plan is to sink the well at the highest point on the land sought to be irrigated; here a large basin is formed, the water in which will be several feet deep. From this the ditches may extend, following the elevations and rises in all their various crooks and turns and so placed that the water may be run from either side onto the tracts devoted to crops. Temporary dams can be put in and the water handled with practically the greatest ease and convenience. Mr. Gibbs saw corn-fields in Kansas where the crops reached to the top of his head, the growth of which, so far as moisture is concerned, has been regulated if not entirely by the farmers themselves, who obtained their water supply by means of extensive ditches from the Arkansas River.

Such extracts show the feeling of our people on the subject of artesian wells. There are other articles and correspondence from prominent papers which I leave with the committee, asking leave to read the following from the Deadwood Weekly Pioneer of July 18, 1889:

The experience of the farmers in the Black Hills counties of Dakota during the past ten years has fully established the fact that fair average crops can be raised every year without irrigation and that by reason of superior soil better crops have been raised here than in many other localities where the rain-fall has been greater. While this is true as a rule, there are certain localities where irrigation is to a large extent almost essential to the certain growing of large crops. Such is the case with the valley of the Belle Fourche, than which no finer body of land exists; a rich, deep sandy loam, which ordinarily, without an artificial water supply, raises a fair crop—yet of such a character that where irrigation has been tried the results have been almost wonderful and not excelled in any section. The effect is not only felt upon the grain crops, but upon the hay and grasses, small fruits, and especially trees of all kinds, both native and cultivated, which will soon give a different appearance to the face of the country. Even in the most desirable localities, where good crops are the rule, without irrigation, very much larger and more uniform yields would be the result if a system of irrigation were introduced.

Very many of the smaller valleys in this district are already covered by ditches, the result of the co-operation of the farmers living along the small mountain-streams,

but it remains for something more than local capital to turn the waters of the Belle Fourche upon the fertile valleys adjacent and thus open up what will in a very few years prove to be the garden spot of the West; the Egyptian fields of Dakota.

I ask leave, also, to present to the committee certain papers intended for business purposes in promoting the construction of irrigation works named in them. I have indicated the portions which state facts that bear on the inquiry this committee is making, and ask that, if approved of, they be incorporated as part of my statement. These papers relate to a canal in process of construction in the Black Hills. Under date of July 26, last, the engineer writes:

I surveyed and laid out both the Choteau and Harrison dieth, and the Red-water ditch. The first mentioned, if I remember right, is nearly 3 miles long, and has a grade of 3.2 feet to a mile, or a hundredth of a foot to a rod. The Redwater ditch has three hundredths to 2 rods for the first 3 miles, then the grade is heavier for several miles. The Redwater ditch carries, at present, from 2,500 to 3,000 inches of water, all of which is used along its line for irrigation. A great deal more could be sold if the ditch had a greater capacity. The Redwater River, from which these ditches are taken, flows from 8,000 to 10,000 miners' inches of water when at its lowest. It has a good fall and low banks, so that ditches can be taken from it easily at nearly any point.

Three or four miles below where the Redwater ditch is taken out, is the confluence of the Belle Fourche and Redwater Rivers. The Belle Fourche has a much longer water-shed than the Redwater, consequently it is more liable to high water and freshets. In the dry season it affords only a small quantity of water, while in the wet season it is a large river. It runs deep within its banks, and being subject to extreme high or low water, it is very difficult and costly to take a ditch from it. It has only about 7 feet fall to the mile.

The Redwater River is not subject to the extremes in high and low water as the Belle Fourche. It has a more even flow, being more of a mountain stream, and flows several times more water than the Belle Fourche at the time water is needed for irrigation. All the water of this river could be sold to the farmers for irrigating, if a ditch or canal were built large enough to take all the water out of it. Such a ditch, if extended 30 or 35 miles, would cover several thousand acres of as good farming land as there is in this or any other country. This land is at present, all or nearly all, located and proved up on, but the greater portion is unproductive because the farmers are discouraged, trying to raise crops without irrigation; while those who can get water from the ditches now in operation try to increase their acreage each year. The land is very productive under irrigation, yielding from 30 to 50 bushels of wheat per acre, and other cereals in proportionately large quantities.

A canal 16 feet wide, on a grade of 3.2 feet to the mile, would flow 6,000 inches of water. It would not be necessary to build it with an even capacity the entire length, as the flow would be less at the lower end on account of the water let off for irrigating along the line. When a suitable place was determined from which to build the proposed canal, the line could be surveyed and staked off in sections of, say, 100 rods each, and cross-sectioned, so as to calculate the number of cubic yards of earth to be removed, and contracts let all along the line which, when done, should be approved by the company's engineer before it was accepted as completed. There are no great obstacles or difficulties in the way of building such canal. It can be done cheaply, and will be permanent when made, as there will be very few flumes along its line. After the first year or two it will not require much work to keep it in repair, and the demand for water will always be increasing. The first few years the ditch would be in operation, as I have before stated, it will cost more to keep it in repair than when it is settled and stanch. The demand for water will also increase so that the percentage of profit will ever be on the increase. There are to-day from fifty to one hundred farmers living under the line of the proposed canal, who are anxious to get from 50 to 100 inches of water each, and who would no doubt help to build the ditch by taking part of their pay in ditch scrip or stock that a company building said canal would guarantee to take in pay for the use of its water.

The land below the line of this proposed canal has a gentle slope toward the river, so that it is peculiarly adapted to irrigation in that respect. The valley is about 3 miles wide, and, on a rough estimate, I should say there was 20,000 acres of land that could be irrigated by a ditch extended from Redwater River on the south side of the Belle Fourche Valley, 25 to 30 miles long. There would be no trouble to sell the first year 6,000 inches of water at \$1.50 per inch for the season.

From the other business paper, relating to the project referred to, I submit the following:

We have had several preliminary levels and surveys run, and are now more definitely informed as to the situation than at that time. Upon examination we find that the great bulk of water in the "Belle Fourche" River comes from the "Redwater" River, and that it is much more feasible to tap this latter stream than the Belle Fourche. That a ditch or canal can be constructed and the water of the "Redwater" or, practically, all of it, now available, say 8,000 inches, taken out at a point some 3 miles above its confluence with the Belle Fourche River, and carried a distance of about 25 miles, and cover nearly 30,000 acres of land, two-thirds of which is desirable agricultural land that can be irrigated by this canal in the course of two or three years.

The expense of securing the prior rights to the water, and constructing the ditch, would hardly exceed \$50,000, and the income in 1890, from land already under cultivation, would be about \$5,000. This, we think, beyond question, would increase \$2,000 to \$2,500 per annum, until the limit of the ditch was reached. This, in our judgment, will be about \$15,000 per annum and likely more.

The irrigating season lasts five months at the outside, though really two months covers the heavy work. During the five months a canal properly organized would require an active business agent and manager to make contracts and collections, at, say, \$150 per month; also one foreman, at \$80 to \$100, and two laborers, at \$40 each, or \$330, and, say, \$20 per month for sundries; making a total for the five months of \$1,650, and for the seven months, one man (part of his time) at \$30, or even less, say, 200, while office expenses of all kinds would hardly exceed \$600 per annum, thus making a total expense of about \$2,500 per annum, of 5 per cent. of the capital \$50,000.

This would be independent of construction cost, to be invested. The office work would increase with the greater demand for water, but nothing in comparison with the increased income. While the expenses of the first year would likely be at least 50 per cent. of the income, the second year it would be less than 40 per cent., and the third less than 30 per cent., and so on until it would reach a minimum of about 20 per cent.

Land that to-day without irrigation is worth \$5 to \$10 per acre will more readily sell for \$10 to \$25 under the proposed canal. There are several thousand acres of this land (a rich, sandy loam, desirable in every way, except water), that could now be bought for \$5 to \$10 per acre, and which would pay a big profit inside of three years, and meantime pay good interest from rentals whenever water is put upon it.

The valley of the Belle Fourche River, below the mouth of the Redwater River, for a distance of 30 miles eastward is about 3 miles wide, and peculiarly adapted by nature for irrigation on account of its grade and the incline of the plateau or bench lands towards the river. The valley is sparsely settled, and much of it unoccupied at present, but with an assured artificial supply of water by means of irrigation the valley would soon become thickly populated and the demand for water far greater than the supply obtainable. One ditch has been in operation for some years, but under a co-operative management, not calculated to be successful. A small portion of the land has been cultivated for some years, with fine results as to the quantity and quality of productions, the wheat weighing 61 pounds and over to the bushel, oats weighing from 36 to 41 pounds to the bushel, barley and rye in proportion. The root crops are magnificent and the potatoes command the highest price in every market. All small fruits yield abundantly; strawberries and raspberries grow wild, while the adjacent lands to which the ditch has not been extended are to a great extent uncultivated. The principal water supply is from the Redwater River, which has a fall for the last 5 miles of its course of 25 feet to the mile, and carries about 15,000 inches of water, of which 8,000 could be appropriated and utilized. The first 22 miles of the valley contains some 30,000 acres of land on the south side alone which can be brought under the line of a canal, which is sufficient to consume all the water which can be carried to it. A canal for irrigating, water-power, and domestic purposes can be constructed down the south side of the Belle Fourche valley, the supply being drawn from the Redwater River, with a capacity to irrigate 16,000 acres, at a cost of construction not to exceed \$3.50 per acre of the area to be irrigated; that is, to irrigate 16,000 acres will cost \$53,000 or less. The line of the canal will pass through one village on the projected line of a railroad, which is situated on a plateau 50 feet above the Redwater River, thus permitting the canal to furnish a grand water-power for manufacturing, town use, and other purposes. The sale of the water for irrigation on 16,000 acres at a rental of \$1 per acre will produce a gross yearly income of \$16,000, equivalent to 30 per cent. per annum gross on the capital invested in the canal alone.

The capitalization or cost varies according to the distance of the supply of water

and the difficulties encountered in the construction of canals. In some places it has reached as high as \$40 per acre of the area to be irrigated. The "seventy-six" canal at Fresno supplied 20,000 acres at a capitalization cost of \$6 per acre. In Colorado it has been estimated that the cost of canal construction is from \$5 to \$6.25 per acre of the area to be irrigated.

Originally the cost of the water required to raise a crop depends upon the capital required to construct the works and canal, but as the land continues to be cultivated and larger areas are brought under cultivation the price of the use of the water increases, so that the value of the "water right" grows constantly, and a purchaser at a later date must pay a proportionate advance for an interest in the water.

The average cost of rented water for each season in the dry regions of the United States is from \$2 to \$6 per acre; in Italy and France from \$2 to \$7 per acre. The lowest water rent paid by consumers varies from \$1 per acre in Utah to \$1.50 per acre in Colorado and \$2 per acre in Kansas.

The conditions as to climate and kinds of products raised in the irrigated parts of Colorado and the irrigable parts of Dakota are practically alike, so that results which have been obtained in Colorado can also be obtained in Dakota, with the further advantage of possessing better soil. A part of Butte County, Dak., is in the "dry region," where irrigation can be practiced with success for the certain production of large crops. All kinds of grain, vegetables, and fruits can be raised there which are raised in northern Illinois and Iowa. The soil is rich and deep, and the finest No. 1 hard wheat and other cereals have been raised for the past seven years.

I do not know of anything further that I can do or say, except to give to the committee the benefit of my twelve years' experience in eastern and western Dakota. In my judgment, unless a survey is afforded by the General Government, much of the land that is open to settlement will not be settled, and it will remain in its original condition.

The CHAIRMAN. Has the cutting of timber made any difference in the moisture of that region—that is, has it affected the streams?

Mr. WILSON. I can not say as to that. Large quantities of timber have been cut, but it is in that particular section where rain is not used. The water supply has decreased for several years. We have no floods now. The mountain streams which ran through Deadwood several years ago nearly devastated the town, but we have had no floods for several years.

The CHAIRMAN. Have you any data showing the rain-fall in that section?

Mr. WILSON. I think it is about 25 inches a year—that is, I so understand the figures. There is a gentleman here who has the data. The station at that time was located at Deadwood, which is in the mountains, and which is higher. The rain-fall is greater there than through the lower districts of which I have been speaking.

Senator REAGAN. Have there been any attempts at boring artesian wells in the Black Hills country and west of the Missouri River?

Mr. WILSON. No. The only country settled west of the Missouri is the Black Hills. There they have some systems which will irrigate a portion of the land. These artesian wells have been built only in the cities where there is a co-operation of capital. It would be impossible for farmers to go about constructing these wells. Experiments can be made only by capital. When the fact of irrigation by means of artesian wells has been established, then the farmers may co-operate.

The CHAIRMAN. Have you any irrigating ditches in that vicinity at the present time?

Mr. WILSON. We have.

The CHAIRMAN. Can you state where those ditches are, and approximate the amount of land which is under irrigation in that region?

Mr. WILSON. I can, generally. On the headwaters of a stream, carrying about 20 to 25 inches of water, and in its lowest season 10 and 12 inches, there was a ditch built by the farmers which at first was 9 miles in length and which has since been extended 9 miles further, making 18

miles in all. That ditch covers about 5,000 acres of land. About a week ago I went to the bluffs overlooking this valley, and along the line of the ditch the fields were magnificent in appearance, yielding large crops, while above it was a barren waste, the stream marking the line between poverty and plenty. That stream originates in the mountains some 30 or 40 miles distant, and there you may store a good deal of water—from 25 to 30 inches of water. There are numerous places where reservoirs could be erected and the supply of water increased from 10 to 30 inches, and the amount of land to be irrigated from twenty to sixty thousand acres. They have about 5,000 acres under irrigation now, and the value of a farm under that ditch is from two to three fold greater than a farm that can not be irrigated. I know of land better than that which was under that ditch, and it was abandoned because the parties could not live upon it.

The CHAIRMAN. Is that the only ditch of which you know?

Mr. WILSON. On the Spear Fish you will find a number of private ditches along the stream. There is no organized company for constructing these ditches; but a few farmers will build a ditch to cover their land, taking out a sufficient amount of water for their own purposes. In that valley I should say there are from three to six thousand acres of land irrigated in that way, and the value of that land is from two to three fold greater than land not irrigated. I know a farm there selling as high as from \$20 to \$40 an acre, and it was made valuable by reason of irrigation. There is no reason why if artesian wells could be made a success, the value of the land in the valleys of Dakota should not be run into the millions of dollars.

Director POWELL. Have you computed the relative cost of securing the use of a given amount of water by artesian wells and by storage?

Mr. WILSON. No; but I can say to the committee——

Director POWELL. Suppose that it would take an acre of water 12 inches deep to irrigate an acre of land for a season; you might get that water in some regions by boring for it and it would cost so much; or you might get it by storing the surplus water which falls in that territory when irrigation is not necessary. Then the practical question for the farmers of Dakota more than for the rest of the country is to know whether that acre of water 12 inches deep will cost more one way than it will another. I wish to know whether you have considered the question of the difference of cost of storing water and of boring for it.

Mr. WILSON. I have looked at it in this way: To ascertain the cost of irrigating the land generally and then comparing the value of the land irrigated as compared with land not irrigated. The estimated cost of constructing irrigating ditches, taking that as a basis first, will run from \$5 to \$25 an acre. To irrigate 160 acres of land will cost from \$800 to \$2,500; and in portions of Colorado they are paying a bonus of from \$5 to \$10 an acre for the privilege of buying water. They pay there the value of the land every year for the privilege of buying water.

The CHAIRMAN. Would you not be satisfied at the present time for the Government to make a survey, and estimate what is necessary to be expended to accomplish irrigation in the different portions of the country? Do you not think it would be best to ascertain what we have before expending any money?

Mr. WILSON. I am afraid some of the gentlemen before you would be in their graves before relief would come from legislation on the part of the General Government if speedy action were not taken. We take it that this committee is friendly to this enterprise, know the benefits to be derived from irrigation, and that you will urge the matter upon

Congress. These gentlemen have told you what has been accomplished by artesian wells; but they are for domestic uses in the cities. Now, why should not the Government make a trial on its own land? It would take but very little money.

The CHAIRMAN. Suppose Congress should come to the conclusion that artesian wells would be the best scheme for reclaiming these lands, would it be necessary for the Government to do more than ascertain the extent of the artesian belt by sinking experimental wells?

Mr. WILSON. That in my judgment would be feasible if our people were as far advanced as they are in the older States.

STATEMENT OF JOHN J. CUSHING, OF ASHTON, SPINK COUNTY.

Mr. Chairman and gentlemen; I am here from Ashton, Spink County, Dakota. We now consider ourselves a part of the United States, and as such entitled to all the rights and benefits pertaining to the people of a free republican government, which rights and benefits include appropriations.

The wealth of any country depends upon the production of that country. In Dakota Territory, the best calculation for the last two years places the loss at \$25,000,000 a year from the failure of its water supply; and that is a loss to the whole country also. We are in one of the most singular portions of the United States, a belt extending from the Gulf of Mexico to Hudson Bay. It is evident that something should be done to improve that country. Nature has done its work, and now we want a little art applied. We have what we believe to be an inexhaustible supply of water underneath the surface of the earth. I have taken pains to investigate annually the precipitation in the different parts of the Territory. I find that the annual precipitation for the Territory as determined by 29 points of observation from July, 1875, to December, 1886, has amounted to 22.35 inches. Of these 29 points 15 have fallen below 20 inches while 14 have run above that. Taking the points along the James River valley, in which I live, it being the most thickly settled portion of our Territory, and we find at Huron, which is the only point in our county where observations have been taken, that the average precipitation annually is 23.65 inches. The country around Huron is comparatively level. We are situated below the Coteaux.

The CHAIRMAN. By that, you mean a range of hills?

Mr. CUSHING. Yes. The Coteaux are situated east of the James River and west of the Missouri River, and some distance from each. Now, Webster, a place on the east side of the James, in Day County, is surrounded by small lakes. There are a good many small bodies of water around that town. At Huron there are no bodies of water to afford surface evaporation. The precipitation at Webster is double what it is at Huron, and that to my mind indicates that rain-fall is affected by evaporation.

I have here a map of Spink County, on which I have marked in red ink the natural water-courses which are dry, and the natural lake beds which are dry, showing the drainage system in our county. In this county, at Ashton, we have an artesian well; at Redfield we have one; at Frankfort we have one.

The CHAIRMAN. When you strike the first flow, what is the character of the water?

Mr. CUSHING. The formation is almost the same as the other, but it is a narrower stream of water. The contractor told me that when he

struck water at Redfield his drill dropped down apparently 925 feet in the quicksand or an open place. At Frankfort after they had completed their well they were experimenting with it, showing the people the pressure they had, and they closed the well up. At that time the pressure of the water burst the pipe, which is a 6-inch pipe, down some 600 feet below the surface. The water ever since at that place where it burst the pipe has been coming up outside the pipe, bringing the soil with it, and for that reason the water is sometimes thick and muddy. It comes up with the same pressure, and they have been obliged to abandon the well for domestic purposes. This water runs into a small ditch along the railroad down to the James River 2 or 3 miles below. I was there two or three weeks ago and I noticed the vegetation along this small ditch, and for at least 12 rods on each side of the ditch the vegetation is nearly four times as large as it is outside of that distance.

Now, I do not think we really need what is called surface irrigation. We need what I should term sub-irrigation. We have a subsoil about 2 feet from the surface, which is almost impervious to water. The subsoil during the winter of 1879 and 1880, when we had deep snows in the Territory, was thoroughly filled up. At that time all the rivers and small streams were filled with water. For two or three years after that, 1881, 1882, 1883, and 1884, these streams were evaporating, and we had good falls of rain and good crops; but the rain-fall has been growing less, and to-day those streams and lake-beds are entirely dry. The evaporation has totally dried them up, and, of course, we get no benefit from surface evaporation.

What is to be done? I believe that the Government should take hold and place artesian wells at convenient points in this James River Valley, and run water into these old water-courses and lake-beds, fill them up, and give us a good supply of surface evaporation.

I brought with me a few samples of grain to show to the committee what we can do in Dakota. These two samples of wheat [exhibiting] are the result of irrigation. Here is a sample of the general run of wheat [exhibiting] which is the result of no irrigation. These two samples of oats [exhibiting] are the result of irrigation. The wheat and oats which have received the benefits of irrigation are 4 feet in height, with the heads ranging from 12 to 14 inches on the wheat and 12 to 13 inches on the oats. The wheat which has not received the benefits of irrigation stands about 14 inches high, with heads about an inch long and with but few kernels in them. Now, when I speak of the results of irrigation I mean this: These two samples of wheat are the result of what is termed in our country "sub-irrigation." Last winter there was a little snow, very little. This snow settled in low places and along the fences, and such places where it would stay until it made quite large banks. This snow thawed in spring and filled the subsoil with water. This wheat was grown on low places, and has never received any more water than that sample of low wheat which was grown about 5 rods from the other. This soil on which the large samples were grown received a thorough soaking in the winter, and you see the result.

I believe if we can get these artesian wells—get the Government to bore them, we can apply the water to our soil. We could run the water through the sections of land, and it would percolate through the soil. During the winter we could throw up little embankments around our farms, and turn this water on to them, and thus give the soil a thorough soaking. This could be done by one man from one well in a very few days, and then another could take the water and fill up his land. Could this

be done, though we might have no rain in the summer, we could raise good crops of wheat.

The artesian wells in our country have been sunk by the cities and have not been applied to irrigation. There are three at Aberdeen, and each one has about the same force, and there has been no considerable difference in the flows or the force of those three wells. A gentleman from Aberdeen informs me that while they were taking their water for the sewerage system the water was run off onto a piece of land, about 40 acres, low enough for water to flow on. There were 60 acres too high for the water flow on. Not a piece of grain grown on the ground which was overflowed received a drop of water this spring until the 20th of June, and they have 40 bushels to the acre from that land. The 60 acres which did not receive the benefit of this water will not give 3 bushels to the acre; it is practically worthless. There are in our country quite a number of wells, but as yet none of them have been applied to the purposes of irrigation.

Director POWELL. How long have you lived in the James River valley?

Mr. CUSHING. Nine years.

Director POWELL. How many of them have been successful years for agriculture?

Mr. CUSHING. About three.

Director POWELL. How many of them practical failures or total failures?

Mr. CUSHING. About three—what we might call total failures—about one-third the time.

STATEMENT OF MORRISON EAGER, OF HURON.

Mr. Chairman and gentlemen, I own several thousands of acres of lands in Dakota myself, and I am imbued with the idea of irrigation. I live at Huron. This is the fourth or fifth crop I have raised and I have not had a failure yet. But I must say that 5 miles from me the crop is a failure; but that is for want of irrigation. Why it is that the people of James River Valley do not irrigate I can not see.

At Jamestown there is a well 800 feet deep; one 600 feet deep at Yanktown, the mouth of the James, and one 802 feet at Huron. You can get a flowing well at, perhaps, 400 feet. I know of flowing wells varying from 375 feet to 800 feet; but where the water flows without any great pressure. At 802 feet we struck sandstone. Now, I can show two wells within a mile or two of this well, that is at Huron, where there is a continual flow, but no pressure at from 400 feet to 700 feet. The first one was soft water and the second was hard water. This sandstone is practically 40 or 50 feet in thickness. Were we to go into the third sandstone what would we find? As steam is to water, so gas is to make the pressure of these wells. I maintain that the Trenton rock or third sandstone will show what this pressure of water is in the James River. The second flow is hard water, impregnated with gas, and at Miller they can set it on fire. Gas, I maintain, is the power behind this water, and that the force is not by water seeking its level. The chairman asked whether it ever happened that no water was found. At Salem the contractor in sinking a well struck granite, and the parties paid him his contract price although he abandoned the work without getting water, because he struck granite—the backbone of the earth.

Highmore is the highest point on the James River and the Missouri. If you go further west or further east, it does not make any difference

you will find this artesian belt of greater force than at Highmore. That is the case at Miller, 35 miles west. Proportionately as you range the James River Valley you will strike water at 802 feet, and at 1,552 feet, as there is a rise in the land between Huron and Highmore.

STATEMENT OF WALDO M. POTTER, OF LA MOURE.

Mr. Chairman and gentlemen, I do not purpose taking much of your time, but I feel desirous of impressing upon the members of this committee the importance of some action by the General Government touching the needs of Dakota. And to show you how general that sentiment is I will read you my commission here. It was issued by the board of county commissioners of La Moure County, which is in the James River Valley, about in the center, between the Missouri and Red Rivers.

Now, I need not take your time to speak of the situation to any great length, because it has been dwelt upon here already. The same condition of things, so far as the lack of rain is concerned, exists where we are as farther south. I say there is a lack of rain at the right time to insure the growing of crops. But I wish to call your attention to what our commissioners have stated to our county. Here [exhibiting] is a map very elaborately drawn to show the surface of the county. This shows where, six years ago, Bone Hill Creek in the northern part of the county, Bear Creek on the eastern border, and Cottonwood Creek in the center, each extending through several townships, were considerable streams, but are now almost dry.

The CHAIRMAN. What amount of water is in the James River?

Mr. POTTER. There is a very small amount. Six years ago sloughs nearly impassable by teams were scattered in a majority of the townships, but they are now all dry. The twin alkali lakes, 3 miles from the town of La Moure, nearly 2 miles north and south, and from 10 to 12 feet deep, now one is dry and the other nearly so. Cottonwood Lake, 1 mile long and one-half mile wide, 9 miles southwest of La Moure, is now a shallow pond 6 feet lower than it was five years ago. This is about all the surface water except the James River in the entire 1,152 square miles of county. The James River has been only a shadow of its former self most of the time during the present season. The disappearance of these ponds has been gradual, more or less from year to year, in the face of the generally received theory that cultivation of the land increases rainfall. Probably the cultivation of the surface has one effect—to arrest the falling water before it reaches the water courses. At the same time it is evident that the supply has diminished, and that our farmers have been suffering more and more, from year to year.

What is true of La Moure County in these three respects is also true of nearly all the present occupied portion of the two Dakotas. I have here letters from other counties, written since the formation of your committee. I was appointed by the county board of commissioners to meet you gentlemen, and I entered into correspondence with other counties in the Territory, and I find the same sentiment, the same disposition, everywhere as to the needs of Dakota.

We think that the General Government should initiate this movement, and that it is feasible. I do not know that there is any part of Dakota, of either of the Dakotas, east of the Missouri River where artesian wells are not feasible, because in Yankton county they have about 30 wells at a depth of 600 feet, with a pressure of from 60 to 70 pounds to the square inch, and the depth increases as you go north. But wells

are in existence over the whole distance, over a surface of nearly 400 miles north and south, and about 200 miles east and west. There are wells at Huron, at Aberdeen, farther north at Jamestown, at Groton in the Red River Valley. If there were any doubt about it, it would be there. At that place there is a well 528 feet deep which flows a thousand gallons a minute. There are several wells in Cass County, in the region of Fargo; two wells which show their practicability.

Here is an extract from a newspaper, the Hope (Steel County) Pioneer of July 19, 1889, with reference to the waste water of an artesian well :

The result of the waste water from the Hitchcock artesian well is that on either side of the ditch for a distance of from four to six rods the yield of grain will be from 50 to 100 per cent. better; that all the ground that was flooded in the spring by the water from the ditch will yield from 25 to 50 per cent. more grain; also that the grain is green and that the head is filling plump to the tip, and that the dry weather and hot winds have not affected it in the least.

The feasibility being settled, we now come to the necessity of it. It seems to be absolutely certain that we must have some moisture in order to keep up agriculture in Dakota. I can state some facts in regard to our own county, of people who have abandoned their farms. I know neighborhoods where several farmers have abandoned their farms after they had broken up the land because of a continual failure of crops. One of our county commissioners left our county. He said that he brought several thousand dollars into that county but could not stay. He was a temperate man, a German, and he was close-fisted, and he said he was compelled to go because his crop had failed from year to year. The showers that come into Dakota are spasmodic—intermittent. Sometimes one man will have a good crop while his neighbor will have no crop at all, and that is owing entirely to the lack of moisture. It is that fact which has to-day created that unrest, doubt, and discouragement which are prevailing characteristics of the grain-growers of Dakota. Dakota is a great country; it has great possibilities; there is no soil that is richer. In my experience I know of none that is so rich. We have a fine climate. I lived a large part of my life in the State of New York and ten years in the State of Iowa, and I give the preference to Dakota. The eight years that I have lived in Dakota have been the best eight years, so far as continued good health is concerned, of my life. We lack but one thing, and that is moisture, and on that account the majority, I should say all, the farms are heavily mortgaged, and we think the General Government ought to give us assistance.

The CHAIRMAN. Is there much public land in your region?

Mr. POTTER. Not in our region. In the last statement of our commissioner it appeared that the Government owned 21,000,000 acres of land not entered, but open to entry. I do not recollect the statement as to survey. But the fact was that there were 21,000,000 acres open to entry.

The CHAIRMAN. In North Dakota?

Mr. POTTER. In both the Dakotas. This was the report of the Territorial immigration committee—21,000,000 acres subject to entry and 10,000,000 acres to be added from the Sioux Reservation.

According to the best light that I have been able to get on the subject, and I have written letters to each of the receivers of the land offices and received replies principally thus: The General Government has received, in round numbers, from North Dakota alone, \$7,529,400.

The CHAIRMAN. That is principally from pre-emption entries?

Mr. POTTER. Very largely from homesteads, because homesteads very largely have been turned into pre-emptions. I suppose it is a fact

that more than one-half of the money that has been paid into the General Government has been paid in there by farmers who turned their homesteads into pre-emptions, because they wanted to borrow money. They had been disappointed in their crops, and they would borrow money and pay the General Government \$1.25 an acre in order to get money. Therefore, a large amount of this has gone into the Treasury from that source. But from South Dakota, Aberdeen and neighborhood, \$7,000,000; and I was told by a receiver of the Huron office that he received \$3,000,000 during his term of office, and I estimate \$10,000,000 more from the southern offices, making in the neighborhood of \$20,000,000 paid into the national Treasury from the settlers of Dakota. Under these circumstances and the extent of the discouragement under which the people of that country suffer, we think the General Government ought to be liberally disposed toward them. I do not expect any large appropriation from the General Government in the way of sinking wells, at least at the start, but I do expect that this committee will recommend that Congress grant a liberal appropriation for surveys and investigation in regard to what can be done for the advantage of the two Dakotas in that respect; that the General Government will send experts who understand the business, who have made it a study; men who will thoroughly investigate the matter, and perhaps make some experimental trials in regard to these artesian wells.

Senator REAGAN. Have you made any estimate of the probable cost of sinking artesian wells?

Mr. POTTER. No; I have had no experience; but I believe the expense has been from \$4,000 to \$6,000. If this work is entered upon with the best appliances for doing the work, it could be done by wholesale more cheaply than in these isolated localities.

STATEMENT OF L. R. CASEY, OF JAMESTOWN.

Mr. Chairman and gentlemen, I will endeavor to set an example of what you seem to desire—brevity.

Representing the Farmers' Alliance of North Dakota, I desire to express for myself and for them the exceeding gratification we have felt that in the great work you have undertaken Dakota has not been omitted.

I was appointed by the constitutional convention, now convened at Bismarck, a messenger to deliver to the committee at this point a memorial drawn by the convention and passed by it. I can only report to the committee that it has not reached me by this morning's mail, which is just as well, as the committee will get it when it arrives at Bismarck.

Data have been presented to the committee, which are general in their character, pertaining to the different wells. It is not necessary for me to present additional data. In North Dakota we have two wells, in Ellendale and Jamestown, both of excellent character, of which you will get definite information. Here [indicating on the map] is Devil's Lake, due north from Jamestown, and in the James River Valley, James River turning off at a given point. Here is Devil's Lake City on the north side of the lake. A well has been recently put in successful operation there, of which I know very little.

The CHAIRMAN. Has that lake any water in it now?

Mr. CASEY. It has a large body of brackish water. It has no defined outlet. It is full of fish and of great depth in the middle.

The CHAIRMAN. If fish can live in it, it could be used for irrigation purposes.

Mr. CASEY. Undoubtedly. [Indicating on a map.] James River comes off in this direction. The Cheyenne River has its source a few miles from the James.

The CHAIRMAN. Is that lake lower than the surrounding country?

Mr. CASEY. Yes; it is lower than the surrounding country.

The CHAIRMAN. It can not be made a reservoir?

Mr. CASEY. No, although it lies 100 feet higher than Jamestown; possibly by cutting channels it could be used.

The CHAIRMAN. Is there much of a ridge between it and the James River?

Mr. CASEY. Yes, a high ridge. I do not know the figures. I have inquired for a map showing the topography.

The CHAIRMAN. If that lake could be turned down southward [indicating] it could be made to contribute to the James River?

Mr. CASEY. No; the level of the James is above.

The CHAIRMAN. You might turn other water into it.

Mr. CASEY. Possibly the Cheyenne.

The Cheyenne, at first parallel with the James and near it, continues its course farther east, then like the James flows nearly south, but after about 100 miles, turns about to the north, joins the Red near Fargo, and finally its waters go into Hudson's Bay, while those of the James go to the Gulf of Mexico.

In many places in the Red River Valley water is obtained at a depth of 200 or 300 feet, without pressure, and with slight overflow. Greater depths have not been satisfactorily tested. There is a deep well at Grafton, but I have failed to receive a report of it. I know the water is salty. Let me mention that the first flow of water at Jamestown, 1,300 feet down, was salt. It was piped off, and the water finally got 1,500 feet down has a mere trace of salt in it.

Shallow artesian wells such as I have referred to have not generally been of value for irrigation. The water from some of them is injurious to vegetation, and none of them give sufficient supply. It is the water from great depth—from what we suppose is the true artesian basin—that is valuable. That at Jamestown yields 375 gallons a minute and it comes through a 3-inch pipe at the bottom. It has a pressure of about 90 pounds. Such artesian water has not been extensively applied to irrigation. The wells are generally in the towns. It has been used in a small way successfully and grass under its influence grows luxuriantly. The people are confident of its suitability to irrigation.

I desire, if the committee please, to present some considerations, in addition to those already presented, as to why we may fairly and boldly claim that the Government shall to some extent aid us at this time in the direction of irrigation.

Farming in Dakota was begun in 1875 by a few venturesome parties in the Red River Valley, but it was 1878 before confidence was established in Dakota sufficient to induce emigration to North Dakota. In ten years (from 1877 to 1887) the population of Dakota, as a whole, increased from less than 100,000 to something over 600,000. Of that population North Dakota in 1877 had not more than 20,000. In 1887 it had about two-fifths of the whole. The basis of that large emigration to North Dakota was the great success of cropping lands, and the emigration to the country was almost entirely east of the one hundredth meridian.

That success continued until 1883. During that summer the precipitation was deficient. For the year it was about as usual, but while in other years there had been good rains in June or July, that season it was not so. And in every year when there has been such lack crops have not been so good.

I will give you one illustration. In the year 1886 there had been scarcely any rain-fall in the first part of the season in North Dakota. The crops were languishing, and discouragement began to come over the people. On the 3d day of July there was a copious rain, lasting fifteen or twenty minutes in the James Valley, and in all the Red River Valley three hours. The farms in the Red River Valley that had been cropped eleven years without rest, the reports show, gave larger crops that season than ever before, and it all turned on that great rain of the 3d day of July, which we regard as one of the most potent arguments in favor of irrigation. Because with irrigation water can be applied at the critical time.

In 1884 and 1885 two impressive facts dawned upon the settlers in the country: First, that the rain-fall was capricious and could not be depended upon; and second, the other fact that prices were gone. Previous to 1882 the average price of wheat had been from 95 cents to \$1 per bushel. If we had that price for wheat we would take our seasons good and bad and compete with every other section; but when our prices are reduced to from 50 to 70 cents a bushel, we find it impossible to get ahead.

The CHAIRMAN. Have the people of Dakota made any effort to ascertain what caused the low prices?

Mr. CASEY. Oh, yes; I understand your theory. The people have given attention to this fact. All the commercial history of the world from the beginning has shown that supply and demand determine values. The supply had increased enormously in the United States. In 1885 the wheat raised in the United States was double that raised sixteen years before. The population had not increased in the same ratio. India came into the field, South America had come in, and this competition was added to that of Russia, and the world was asked to take more wheat than it ever had before. That is our argument; you may have a different one. That is a sufficient answer to the question.

The CHAIRMAN. That is an answer; but India should not have come in.

Mr. CASEY. You have had South Dakota presented to you. The average rain-fall is 25.7 inches at Huron, and at Bismarck, in North Dakota, 19½ inches. So that if South Dakota has a rain-fall of 27.5 inches, North Dakota, varying from 10 to 20 inches in its various parts, certainly has the greater need of irrigation. The fact has been brought out to-day, and it is undisputed, that a farm with the ordinary rain-fall for irrigation purposes is worth double a farm without the ordinary rain-fall, and that an irrigated farm will deliver three times the crop of one not irrigated. I know of an instance in the Gallatin Valley where a test was made on a farm of 160 acres. From that land 100 bushels of wheat per acre were taken, and the owner made a profit of \$2,500 on his 160 acres.

These, then, are some of the main considerations with which we present our case to the committee, and which I apprehend will be the case which we shall carry to the law-makers and to the Government, and we think a proper case in view of the fact that twenty millions of cash has been paid into the public treasury for lands in Dakota. This Territory is filled with a sober, industrious, and frugal people, who have put into and upon the soil their entire possessions, and in no place in the United States has this proposed redemption of arid land been applauded and admired more than in Dakota. I have heard it spoken of everywhere with the greatest enthusiasm. There is no word against

it, and the people know that this great movement has behind it men of ability, men of character—trusted representatives of the United States, who are capable of pushing it through.

But it can not be concealed that they view with apprehension the enormous competition contemplated in the proposed irrigation of arid lands, now practically without farming population, and they feel justified in demanding at the hands of Government consideration for the 600,000 in the two Dakotas already established on their lands and in their homes.

STATEMENT OF C. W. HALL, OF DICKEY COUNTY.

Mr. Chairman and gentlemen, like everybody else who has considered this subject, I have my ideas of what can be done in Dakota, and those ideas I wish to lay briefly before the committee for its consideration. I believe the problem of irrigation should be well considered, and that it should be considered by experts who are capable of going into all the details of the proper methods for supplying and distributing the necessary water. But there are two methods which have been known to the world for all time of supplying irrigation—one, the oldest, by means of reservoirs, by storage. We have on our western border a water surface which I have roughly estimated to be 50 miles in width by 450 miles in length. In our county this water surface in range 66, I think, takes up nearly one-half the rain. In ranges 67 and 68 it takes up nearly the whole, and then runs 30 or 40 miles beyond the Missouri, rising all the way. But this surface is not even; it is intersected every few rods by valleys which are only separated by dome-shaped ridges. These run all the way up the country, and are the beds of certain lakes and sloughs which are generally more or less full of water; this year they are mostly dry. The openings to those valleys are gulches which could be dammed by masonry, and it is easy for an engineer to estimate how much water a year those reservoirs would be capable of taking up and storing.

The CHAIRMAN. In flood time is there much water running down those ravines?

Mr. HALL. Yes. In 1882 and 1883 there were weeks when we could not ford them.

The CHAIRMAN. How is it now?

Mr. HALL. There was a little freshet in the spring on account of the rain and snow.

The CHAIRMAN. Then there would not have been much water to store?

Mr. HALL. Not much.

The CHAIRMAN. In any other year were they as dry as this year?

Mr. HALL. No; this is the driest year we have had for eight years. But I was going to speak of the second method of irrigation—the artesian wells—the system which has been talked of here to-day. That system could be put in operation in connection with the other, and we could have those reservoirs stored with water the year round.

The CHAIRMAN. Have you ever considered the question whether or not you could take out the main rivers—for instance, the Missouri River?

Mr. HALL. There is a storage-shed to the Missouri River the other side of the divide.

The CHAIRMAN. How high is that?

Mr. HALL. The center of that is 200 or 300 feet above the Missouri; not so high above the Missouri as above us.

The CHAIRMAN. If it is higher what would be the difficulty?

Mr. HALL. It would be a pretty big canal. I will leave that subject.

At Ellendale there is a well 1,087 feet deep. It has a 6-inch bore, and cost about \$5,000. It has a pressure of 125 pounds to the square inch. It started at 80, and has since run up to 125 pounds. That well is like the others that have been described here. The water is found in the sand rock, which for a time disintegrates and pours up large quantities of sand; the flow is increased as that passes away.

The CHAIRMAN. To what depth did they bore into the rock? Of what thickness is this water-bearing strata?

Mr. HALL. I have not the figures in regard to that. I can send them to the committee.

Oakes put in a well; and Frederick, 12 miles south of us, has contracted for one at \$3.25 a foot, and we will have that completed this fall.

The CHAIRMAN. Do you know whether any engineers have taken the altitude of the Missouri to see the difference?

Mr. HALL. Mr. Aikley has, but I have not his figures. I have the figures of Jamestown and Bismarck, if you want them.

The CHAIRMAN. What are the figures of those places?

Mr. HALL. The altitude of Fargo on the North Pacific road is 903 feet; of Jamestown, 1,395 feet, and of Bismarck, 1,668 feet.

The CHAIRMAN. That is 300 feet difference.

Mr. HALL. It is nearly 700 feet across the Territory from Fargo to Bismarck.

There are one or two other things which I wish to mention. My acquaintance with this part of the country commenced in August, 1831. In that year the condition of the country was very much the same with regard to dryness that it now is. The Cottonwood was dried up, and only some of the lakes remained full. In 1831 and 1832 there was an immense fall of snow, and the next spring the country was full of water and the crops were the best that were ever known in that section. All through the valley of the James there was a good yield of wheat—24 to 25 bushels per acre was a moderate crop. The yield went as high as 42 bushels. Dews were heavy, and the country generally seemed to be favorable to farming. But since that time the country has dried up. T. W. R. Emery, who had a large farm in Dickey County, sunk \$40,000 in wheat farming. He never had a crop that paid expenses in four or five years, and he was a man who deserved well. My father sunk \$16,000 in La Moure County. But all this country, not only from my own observation but from the observation of military men who told me about it, is liable to cycles of rain. At times the whole country will get wet through, and then it will gradually dry up. On Devil's Lake, covering some 60,000 acres, the steam-boats run across, and it is not as low to day as it was twenty years ago.

We are proud of Dakota, and we are bound to stay there if it is possible to do so. We know that we have there as rich soil as there is in the world. We have land that we wish to sell to people from other sections of the country, and we do not wish the idea to go out that will lessen the value of those lands. But unless something be done to help Dakota other than Americans will have to go there—people who can live on comparatively nothing and feed themselves. The question will be with any one who wishes well of this project, not what will be done, but what can be done. I believe that if the Government of the United States

can not afford to make appropriations for Dakota as it makes appropriations for other States for their harbors, for sea-walls and coast defenses; if it can not appropriate money for our State as it does for scientific investigations of the fish culture, it can lend its credit to build a system of water-works, and we will pay a reasonable rent to have it in our county, and other counties will do the same. In closing, it should be said that the Government of the United States owes Dakota a good deal of money in a moral point of view.

STATEMENT OF N. J. LOWTHIN, OF GRANT COUNTY

Mr. Chairman and gentlemen, I live in the eastern part of South Dakota, on the west side of the Coteaux, on what is termed the divide between the Whetstone and the James Valleys. The Sioux River has its rise in those Coteaux, and through all the valley are two general streams which are known as the Whetstone and Yellowbanks, with numerous branches, all of which are dry. There are lakes in that valley which in former years were high and had a surplus of water in them. To-day they are very low, and the rain-fall since the lakes have commenced to dry up has grown less every year. In 1882, as has been stated, we had plenty of rain and abundant crops was the result. I think we could have some artesian wells sunk in those Coteaux.

The CHAIRMAN. Have you any streams of water that could be turned into the lakes?

Mr. LOWTHIN. No; nothing but the actual rain-fall. I do not know of any other supply.

The CHAIRMAN. You have not sunk any wells there?

Mr. LOWTHIN. No. They attempted it in Grant County, but I think they struck granite.

The CHAIRMAN. Sometimes there may be overlying granite that is drawn up by volcanic disturbances; but when you come to the regular granite there is no artesian well possible?

Mr. LOWTHIN. They do not attempt to drill through it. I do not think there is any other source for us except the supply from those lakes.

The CHAIRMAN. The lakes are dry now?

Mr. LOWTHIN. They are not completely dry, but they are very low.

The CHAIRMAN. Would there have been sufficient water had it all been drawn off this year?

Mr. LOWTHIN. Yes.

The CHAIRMAN. What difficulty is there in the way of drawing it off; what you want is a tunnel, a deep cut?

Mr. LOWTHIN. I do not think we would have to cut very deep.

The CHAIRMAN. Those waters in the lakes do not belong to any one?

Mr. LOWTHIN. No.

The CHAIRMAN. The first means would be to get those waters out?

Mr. LOWTHIN. Yes.

The CHAIRMAN. Then if you do not have enough for your purposes you should try some artificial mode; but the probability is that you will have plenty of water every year. How much water have you there now; how deep and how wide is it?

Mr. LOWTHIN. Some lakes are 10 feet deep, some less.

The CHAIRMAN. What area does the water cover?

Mr. LOWTHIN. Some 40 to 50 acres. There is a chain of small lakes there.

The CHAIRMAN. Has the land a clay subsoil?

Mr. LOWTHIN. Yes. The Pumice-stone Lake is quite a body of water, of a pretty good depth. In the southern part of the county the crop is poor, but in the northern part the crop is very good.

The CHAIRMAN. You want to survey to ascertain how much of the water in those lakes you can utilize.

Mr. LOWTHIN. Yes. That, I think, should be the first thing done—ascertain what can be done, and then the Government can do whatever it may deem proper to assist us.

STATEMENT OF C. E. GRIMM, OF NEWARK, MARSHALL COUNTY.

Mr. Chairman and gentlemen, I represent the district of Marshall and Broad Counties. That district forms part of the north line of South Dakota. The lakes border the eastern part of our county.

The CHAIRMAN. Have you examined those lakes?

Mr. GRIMM. Yes.

The CHAIRMAN. Is there a good deal of water in them now?

Mr. GRIMM. I saw them about two years ago, and a number of them which are now dry had water in them. There is a number of coulées in our county, and in the spring there is a little water running in them.

The CHAIRMAN. Suppose you were to dam those lakes, could you not benefit a good deal of the land?

Mr. GRIMM. Those coulées or ravines are something like 2 to 5 miles in length, and there has once been a good deal of timber on them. Some of them are 2 miles in length, and some of the banks are 100 feet high. Those hills are higher than the surrounding country, and if the water in those coulées could be increased by a flow from wells, we could get enough water to irrigate a large country. Still lower down the valley there is a strip of what we might call heavy land, and there is where the suffering has been this year; there was no water to reach the subsoil, and the poor sample of wheat which was shown here this morning is good wheat compared with that produced in that country. Then to the westward of that is a strip of country where the crops are considerably better. There the water is nearer the top of the ground. We can reach well water from 10 to 12 feet deep. If you were to sink a well 15 feet deep, it would be almost impossible to pump the well dry. And then, on this flat ground, I understand they have struck water at 75 feet, so that they have made splendid wells in that country. Right up the lower end of this valley of which I am speaking, they have an artesian well a little less than 1,000 feet deep, and the pressure from that well is 125 pounds to the square inch. Then they have a well at Andover, another well at Webster, and another at Columbia, in the James River Valley.

In the winter of 1880 there was much snow in Dakota, and there was water from the melting of that snow that staid from 1881 to 1882, and wheat went up as high as 50 bushels to the acre. That proved to me that with a favorable season we could have a large crop any year. But in the spring, as a general thing, we have not enough water to reach our subsoil, and what little we have is dried up by the hot winds which pass over the country in the summer. I think the bad effect of these winds could be obviated by surface water. But as we have no dews and no surface water, we can not raise our stock or farm products, and our country must be either a stock or farming country. Unless something be done the people must dispose of their stock and make a change. A large number will dispose of their farms under

the hammer. Three wells to a township would give sufficient surface water for that country, and we could raise good crops every season. We know that Congressmen generally live on the best in the land, and it is said that Dakota raises the best flour in this country; so that Congressmen, for their own interest, should look at this thing as we do. We do not wish to make more money than we can well take care of; but we do wish to make enough to pay our taxes and honest debts. We can raise stock cheaper than any other section of the country, and there is no land in the world that has better soil, soil better adapted to cultivation, and we do ask that Congress grant us such relief as our needs require.

STATEMENT OF G. S. PERRY OF DOUGLAS COUNTY.

Mr. Chairman and Gentlemen, I think the ground has been pretty well covered by those who have preceded me, and I shall detain you only a few minutes in presenting the views we entertain in our part of the Territory.

I live in Douglas County, in the extreme southern part of South Dakota. When I went to that country in the winter of 1881 we had an abundance of water, and during the summer of 1882 we had as good crops as I have seen in any other country. In the early part of the season we had a good deal of water in our streams. There were four or five that we could not cross. As I have said, during that season we had as good crops as I have seen in any of the States, and I have lived in Iowa, New Hampshire, Maine, and Colorado. I do not think that the crops of any of those States could come up to the crops that we had in 1882. I do not think there was a night during that summer but what we had dews, and these streams of which mention has been made were running full of water; but this season our crops are poor.

In the early history of the county we had 16 bushels of wheat to the acre, and corn 45 bushels to the acre. That was our crop. But soon these streams were without water, and wagon-roads were made all through them. It is my opinion that unless something be done for our relief the country will soon be depopulated. Why, in Davidson there is not one piece of land in five that is inhabited to-day, the people being driven out because of want of water.

The CHAIRMAN. Is there any supply in that county except from artesian wells?

Mr. PERRY. No.

The CHAIRMAN. But you have artesian wells there?

Mr. PERRY. Yes; at Plankington they have artesian wells and at Plankington.

The CHAIRMAN. What pressure of water did you get there?

Mr. PERRY. At Plankington 140 pounds to the inch. Then you go south to Tyndall, and there is a well 600 feet deep. That has a pressure of 122 pounds to the inch. That flows on the surface, the water going into the Missouri River. Parties living adjacent to this well at Tyndall entered suit against the town because of this water running over their land, but before they got the suits into court and under headway they withdrew them, seeing the advantage the water was to them. This surface water from that well makes the land on which it flows worth \$25 an acre, while the land this side is not worth more than \$8 to \$10 an acre.

The CHAIRMAN. Are the banks of the Missouri deep at that point?

Mr. PERRY. Yes; there are high banks there, and timber lands until you get to Yankton.

The CHAIRMAN. How high have you been?

Mr. PERRY. Only to Pierre. I will say in regard to the wells at Yankton that the best well is 165 feet deep, and has a pressure of 140 pounds. They have eight or nine wells there, and one is on the Missouri River, where they are carrying on one of the largest brick manufactories, and all the water is derived from this well, driving the machinery and everything else. There is another matter to which I wish to call your attention, and to which there has been no allusion so far, and that is that from fifty to seventy-five parties having tree claims are compelled to ask an extension of time to carry out their contract with the Government. This is on account of the dry weather in those counties. If wells could be sunk at the heads of Choteau Creek and two other creeks in that neighborhood, it would make each one of them flowing streams. They are only 6 to 12 miles apart, and we might get moisture from them which would assist us materially. But we are poor and not able to get the money to get on and make the experiments.

STATEMENT OF G. E. PURLEY, OF MINNEHAHA COUNTY.

Mr. Chairman and gentlemen, I live in the Sioux Valley, and I am the only representative from that section. Our county is economically managed, and it is out of debt. The Big Sioux has grass growing in its bottom, with but little water in it.

The CHAIRMAN. Where does it head?

Mr. PURLEY. In Codington County.

The CHAIRMAN. I see here (referring to a map), that there are a great many of these small lakes therein. Do they drain into the Sioux?

Mr. PURLEY. They are not drained. Some of them are dried up. It appears, on the map, as if there were a little lake here [indicating], and one here [indicating], but those places are where we get our good grass. They were lakes and streams in earlier days, but there is no water in them now.

The CHAIRMAN. There is water in the Sioux that could be brought back upon the land?

Mr. PURLEY. But there is not enough in the dry seasons. Here is a statement of the rain-fall in our last growing season. I got it from the president of the Agricultural College. It is $4\frac{43}{100}$ inches. We got the idea that Brookings was getting more water than we were. We could see the clouds move around us, and we found that at the same time they had four inches of water and over, we had only two. Mention has been made about this snow-fall of 1881 and 1882. I have lived in Dakota since 1876 and I have noticed this feature in the change of wind currents: They come from the northwest. The start of our snow-fall was a blizzard from the northwest. The water from that snow went into the ground and filled it up so that we could not plow our fields that fall. Then, during the same winter, we had southeast winds that gave us more snow, and the water from that went into the land. But during the last three years the wind has come directly from the south and the north, and it has been without this moisture. We felt a little delicacy at first at being classed as an arid country; but we are not the first to say we want rain. But the rain grows less all the way from the Alleghany Mountains to the one-hundredth meridian. The average fall is less when you get to the one-hundredth meridian, where

it is not enough for the crops. But there is no use in rebelling against nature or your country because there is not enough rain-fall, for irrigation is the beginning of civilization. When we get educated to it, we will find people leaving rain-fall countries and seeking irrigation lands, and we need not be ashamed of it.

When I went to South Dakota, in 1880, the country was new. There was not a post-office in our county, nor a railroad. I sought information from every available source as to the condition of the country. There were signs of drouth, and my friends back East said they could see between the lines of my letters that I was a little uncertain whether it was a place to live in or not. The lakes throughout South Dakota that summer were dried up. There is a lake in the northeast portion of my county—Lake Brant. It covers probably two sections of land. That was dried up, and teamsters used to go over it and cut their timber. East of the line of the railroad there was a lake called Preston, and that was dried up. The northwestern people built their railroad across there. The grass on the prairies burned off about the middle of last July, but on the 14th of August there was a heavy rain, and the grass all grew up again. The season of 1879 had been dry, but I think not so bad as that.

In the winter of 1880-'81 there was a heavy snow-fall. The winter was a very hard one, and it kept up until the 18th of April. That was the first thaw that we had, and then the snow went off just as fast as snow could go, and all the lakes were filled with water. Preston Lake was so full the railroad company had to lay its track around it. Lake Brant was filled with water. The seasons of 1881, 1882, and 1883 were very productive.

The CHAIRMAN. How large is Lake Brant?

Mr. PURLEY. It covers about two sections of land.

The CHAIRMAN. Is there water in it now?

Mr. PURLEY. Yes; the water in it now is about a foot deep. I learned from an old stageman that it was dry in 1870, and in 1872 or 1873 the subdivisions were made by the Government, and at that time it had water in it. This shows that these dry seasons are periodical. In the seasons when those streams were full of water we had rain. But whether that was the result of the water being in them or a coincident, I would not say. It may have been both.

The CHAIRMAN. It is time that you were having a change of season.

Mr. PURLEY. Yes.

The CHAIRMAN. When the good season comes will you give up or will you keep up the fight?

Mr. PURLEY. Solomon says there is no remembrance of past things. But I do not think there is much danger of this being forgotten. There have been no seasons but what we have had dry spells; but some of them are not so disastrous as others. There has not been one of those dry spells but what the farmers would be alarmed. But the rains would come before the crops were killed.

The CHAIRMAN. When you have a good winter and the rain fills the ground above down to the hard soil, and it is well saturated, will the dry spell hurt you?

Mr. PURLEY. No.

The CHAIRMAN. The moisture will carry you through the season?

Mr. PURLEY. Yes. Last fall had the ground been well saturated, with what rain we had this summer we would have had a fair crop. There is no question about that.

The CHAIRMAN. You have here a most favorable feature—the condition of your soil is such that after a while less water will do.

Mr. PURLEY. Yes. There are several farms where there has never been an entire failure. For instance, there is Mr. Cass's farm, north-east of Huron. He has never missed a crop. He made the statement that anywhere within the area of his land where good crops were raised he could dig down 8 to 12 feet and invariably find water. Many farms there are the same way. I maintain that if we can have some means by which we can irrigate in the fall, after the harvest is over, and once in June, we can get along very well without any more irrigation. Once will suit us. If we can sink artesian wells and anchor the pipes so that the water may be kept in the wells we would have no trouble in that country. But there is the difficulty—the anchoring of the pipes; they are blown out of the ground.

The CHAIRMAN. Why not let the water flow into a reservoir?

Mr. PURLEY. We do not want to use that land for a reservoir; we do not want the water to go down to the James. If the water is in natural places it is too low; we want it up high.

The CHAIRMAN. Can you not locate your wells on high places?

Mr. PURLEY. That might be done in many cases. I think that would be a very good idea. Water naturally percolates through the soil. It has been explained here that the James River Valley has a depression of about 500 feet on each side. I have the figures from the engineers of the Northwestern Railroad. You will see from the map that Pierre is nearly west from Huron. The land at Pierre is 150 feet higher than at Huron.

In 1883 on the lowlands the moisture was left, and on my farm there was a hay field of 60 acres on which there was grass 9 inches long. In 1882 I saw potatoes on the scale that weighed 4 pounds, and a single cabbage head that weighed 40 pounds. But I do not propose to go into details, because the ground has been already covered. When you go to Huron there will be some statistics furnished you.

Now, what is to be done in view of the evidence that has been presented here this morning? If the Government will send out promptly and sink a few wells under the guidance of an engineer—there is no necessity for an extended survey—and show the people how this can be done, it will give confidence to them. They will see that there is a reward to follow which will justify the expense to be incurred in the work. If the Government will do this, gentlemen who are in the money-lending business will see that there is a way for their loans to be paid, and those who have to borrow money to sink wells will have confidence that they can pay their debts. There will be no difficulty in sinking those wells. Our people are not a people to contract debts without making provision to pay them. They want to see their way, and when once they do, they will roll up their sleeves and go to work.

STATEMENT OF E. D. DRAKE, OF MINNESOTA.

Mr. Chairman and gentlemen, I am a citizen of Minnesota. I believe Minnesota has been wholly excluded in this discussion. While it is a fact that southern and eastern Minnesota have as perfect a return of rain-fall as any place on the earth, yet we sometimes suffer for want of rain. I have lived in this State for 25 years, and I am acquainted with northwestern Minnesota, northwestern Iowa, and southwestern Dakota. The agricultural land of Minnesota, around a

circle of 100 miles, is the best body of farming land on the face of the earth. That is a pretty bold statement to make; but I think I am correct. I am sorry that the committee is to part from us in the night; because were it otherwise the committee would see that my statement is true.

But there are seasons when we could double our productions by artificial means. I have been farming some 10 or 15 years and I have planted out trees to more than the value of \$50,000. I have spent much money in planting trees.

And right here let me call attention to this latitude, exposed to the winds of the western prairies—winds that in summer and winter come over an unbroken prairie for 500 miles. There a good rain-fall is all lost. But where trees are it is different, and the effect is shown in the grass and wheat and corn. These trees change the direction of the winds, and induce moisture. I have measured crops of corn from my farm as high as 57½ bushels to the acre. I have this year 30 bushels of wheat on a comparatively thin soil. And then my observation has been confirmed by some of my friends from Dakota, and by the chairman of the committee, to the effect that where we have water in the winter in these basins all over our territory we need very little rain during the year. I have cut good, soft, nutritious hay in those places. A farmer who resides within 25 miles of this city said that he sowed a crop of wheat and harvested it without a single drop of rain; the winter snows going off late in the spring gave him the necessary moisture.

I do not wish to detain the committee, but I trust it will incorporate in its report a recommendation that the introduction of trees should be inaugurated as a means of inducing moisture for purposes of agriculture, particularly in that portion of the country which the Government owns. We have given millions of prairie acres, a very great portion of them to naturalized foreigners, who have filed their declarations of intention and taken a farm. We have given freely and required nothing. Had the Government reserved a portion of that land, or attached a reasonable condition with regard to the planting of trees, we should have had a different condition of things in this whole northwest territory. We would have gotten rid of these blizzards and modified our climate with regard to rain and evaporation. Let Congress consider and pass an act upon the subject of planting trees, and let the beneficiaries do the work. If this can be done it seems to me that it will accomplish as much as can be accomplished by irrigation, and even more.

COMMUNICATIONS FROM DAKOTA PEOPLE.

By direction of the chairman, the following communications were filed:

Messrs. D. C. Pierce (chairman), I. Rockaffow, A. S. Whipple, B. A. Rogers, and A. L. Jones, a committee of the Farmers' Alliance, write under date of Ipswich, S. Dak., July 10, 1889, as follows:

In response to a letter from your committee addressed to C. A. Soderberg, secretary of the Dakota Farmers' Alliance, we the undersigned having been appointed a committee for that purpose by Alliance No. 120 of Edmunds County, beg leave to offer the following facts in relation to the water supply of this county, and ask for them a favorable consideration by your committee.

Edmunds County lies near the center of Dakota Territory, on the eastern slope of the "Coteaux du Missouri," having an elevation at the west end of about 1,200 feet, and at this place (Ipswich) about 400 feet above the James River Valley at Aberdeen. The surface is varied from very rolling and stony in the west to gently rolling in the

eastern, and nearly level and free from stone in the central part. The soil is very rich and produces abundantly when sufficiently moistened.

It has no natural water supply except the melting snow of spring which is carried off by creek beds about a mile apart which empty into the James River. These creeks become dry soon after the snow is gone, no water remaining in the country except a few pools, which are dry by the middle of summer. These creeks average at this point when at full flow about 30 feet wide by 2½ feet deep and have a strong current, thus carrying off an amount of water which if it could be retained in the country would greatly increase the rain-fall and furnish an adequate supply for agricultural and stock purposes.

The rain-fall has varied a great deal during the past six years (the time since the first settlement of the country), but one year (1886) having been sufficient to insure a full crop, while the present year is lacking in rain to the extent of almost a total failure of crops. The present drought, however, is partially attributable to a very light snow-fall last winter, as there was not enough to start a flow of water in the creeks. No record of rain-fall has been kept, but it might be set down about thus: 1886, 18 inches; 1887, 13 inches; 1888, 12 inches; 1889 (to July 1), about 3 or 4.

Ipswich has a 6-inch artesian well, depth 1,270 feet, flow 200 gallons per minute, pressure 70 pounds. Water-works and village well supplied.

The most practical way, in our opinion, to increase our water supply would be—

First. To construct dams across the creek beds mentioned, at least one on every section. These need not be expensive. In many places a large amount of water could be retained by a small dam. A few small dams were constructed by individuals last year, but, as we had so little snow last winter, they were not filled this spring. Although the people believe generally in the advantage of these, they are too poor to build them alone, having invested all their surplus in buildings, teams, and tools.

Second. Artesian wells, located at such points as would accommodate the most people, surplus to flow into the creeks to supply the ponds below. At many points these wells in the future could be utilized to run factories, mills, creameries, etc., as their pressure often reaches 175 pounds. The rental of power would pay for the wells.

Third. As a means to secure the construction of dams and wells we need Government aid in the way of bounty, or exemptions, or any other appropriation that will secure the end.

We do not know what power your committee may be clothed with, and therefore may be overstepping our privileges in this communication; if so we hope it may not detract from what good might come from it with better information.

The people—numbering about 5,000—are mostly American and of the better classes, well up in intelligence and education, and they have labored honestly and faithfully to develop this country and make themselves homes, and are worthy of your consideration, but the heavy odds against which they have had to work has covered them with debts and many are discouraged; and only help of the kind we hope you can bring will save us from the shame of many abandoned homes.

Under date of Dickinson, Stark County, N. Dak., July 24, 1889, a committee composed of the following citizens, James G. Campbell, N. C. Sunsmar, R. J. Turner, Timothy Cuskelly, H. L. Dickinson, John A. McGregor, C. H. Klinefelter, sr., Ed. R. Bonney, Jos. T. Scott, A. Hilliard, and Smith Hilliard, forwarded the annexed paper.

To the special committee of the United States Senate appointed to investigate and report on the matter of irrigation of arid lands, etc.:

GENTLEMEN: The undersigned, citizens of Dickinson in Stark County, North Dakota, respectfully represent for your consideration that there is a large tract of land west of the Missouri River in North Dakota, east of the Bad Lands and bordering on the Little Missouri River. This tract comprises several large counties, some of them having territory enough to make each of itself a fair-sized State. Three of these counties, Morton, Stark, and Billings, are organized, and all of them are more or less settled with permanent settlers, having large tracts of land in cultivation. This whole country is undulating, with a good rich soil, capable when sufficiently watered to raise crops of wheat of from 20 to 30 bushels per acre, and from 50 to 90 bushels of oats. Since the settlement of these lands there have been a few seasons when the rain-fall was sufficient during the growing season to show the capabilities of the soil and climate as above stated; but while there have been a few such years the majority have suffered from severe drought during the months of May, June, and July, more especially June. This has led to repeated crop failures, impoverishing farmers, unless rich enough to have live stock to rely upon, and thus retarding improvement and

discouraging settlement. There are several small streams in this region, but the conformation of the county is such that irrigation from the streams does not seem to be practicable. Artesian wells generally distributed might be made to water large tracts directly, and indirectly the whole region by increasing the humidity of the atmosphere and thus increasing the rain-fall. In this whole region the only incorporated town or city is Mandan, on the bank of the Missouri River. All the other towns are mere villages and hamlets, and the settlers are generally poor. This being so the conditions are not favorable for expending money by way of experiment in boring for water. In all that region there is no well of that kind. If it were once established that water could be had in that way in abundant supply at a moderate depth, then we think that private and corporate enterprise would in time supply the country in the manner indicated with water enough to make it one of the most fruitful regions of the United States.

In view of the foregoing we respectfully request your committee to examine and consider the natural conditions and capabilities of the region referred to, and, if deemed proper by you, that you recommend that one or more experimental wells be sunk at Government expense at such point or points best calculated to make a fair test of what may be accomplished in supplying sufficient water by that means to irrigate this country.

Mr. S. Patton, under date of Dickinson, N. Dak., July 28, 1889, writes as follows:

I have just received a copy of Hon. William M. Stewart's letter to the Farmers' Alliance, from which I learn that the Senate Committee on Irrigation will visit this country early next month. Our agricultural department is engaging in a noble work. We have a superior soil, and the topography of the country is favorable to irrigation. Our farmers are not able to make artesian wells, and our streams are deficient in water in a dry time, and have not enough fall to enable us to get the water out of their deep channels. We have much greater need of irrigating wells than near the mountains in Montana, where the great fall of the mountain streams and melting snows give good facilities. Our rain has been deficient three seasons out of six. This is the driest we have had. Most of our early crops are a sad failure. We have had at my place but 2.74 inches of rain this month:

	Inches.
June.....	0.82
May.....	2.77
April.....	.79
March.....	.17
February.....	1.07
Total for five months.....	7.56

We have had but 8.46 inches since last August, and had it not been for the surplus carried over deep in the soil from the heavy rains of last year, no crop could have been made.

I can answer a few of Mr. Stewart's inquiries:

- (a) The extent of arid area in dry seasons embraces our whole country.
- (b) Above find rain-fall for the past 11 months, our rain-fall during the growing season in good seasons is from 8 to 15 inches; that is an average of 11½ inches.
- (c) We have no irrigation, and no means of irrigation; no streams available for dams or reservoirs.
- (d) Dakota is too dry in fall and winter for trees, and many die from drought.

LA MOURE, LA MOURE COUNTY, NORTH DAKOTA.

The following papers were also filed by the chairman of the committee:

ACTION OF BOARD OF COUNTY COMMISSIONERS.

July 13, 9 o'clock a. m. Board of county commissioners in session. Full board present.

Mr. W. M. Potter appeared before the board and invited attention to the importance of an artesian-well system.

On motion the following resolutions were passed:

Whereas experience has demonstrated the lack of a sufficient supply of moisture to insure growing crops, and also an evident increasing tendency in the same direction and from year to year; and

Whereas the sinking of artesian wells, in various portions of Dakota, affords sat-

isfactory evidence of the existence of vast reservoirs, or inexhaustible currents of water, beneath the soil, which may be utilized by the construction of such wells to flood present and open new water-courses; to create reservoirs; and to irrigate large quantities of agricultural lands; and

Whereas it is believed that such an increase of surface water will exert a beneficial effect upon rain and snow falls, and thus afford assurance of an ample supply of moisture for agricultural needs: Therefore,

Resolved, That it is the judgment of this board that public attention should be turned to artesian wells as a resource against the evils now being suffered for lack of rain supply, with a view not merely to county but to State and national assistance in meeting the exigencies of the situation.

Resolved, That we respectfully and earnestly invite the attention of the committee appointed by the Senate of the United States to investigate as to arid lands, to the needs of these northwestern plains, and to the necessity of supplementing the efforts of exhausted settlers with the strong hand of the General Government.

On motion the chairman was instructed to appoint a committee of three to confer with other county committees and the Senatorial committee on arid lands in relation to artesian wells for water supply for Dakota.

The chairman appointed the following persons on said committee: Waldo M. Potter, W. E. Brewer, and G. R. Fralick.

A correct copy.

Attest:

G. R. FRALICK.
County Auditor.

STATEMENT ACCOMPANYING THE COUNTY MINUTES.

The map sent with this paper, represents sloughs and water-courses where water was abundant six years ago. They are now entirely dry, except the James River and two little lakes.

The county contains thirty-two townships, 1,152 square miles, is centrally located between the Missouri and Red Rivers, rolling prairie, and is divided north and south by James River.

Its condition as to surface water.—Six years ago Bone Hill Creek, in the northern part of the county; Bare Creek, on the eastern border, and Cottonwood Creek, in the center, each extending through several townships, were considerable streams; now almost entirely dry. At that time sloughs nearly impassable by teams were scattered in a majority of the townships. These are now all dry.

The twin Alkali Lakes, 3 miles from the town of La Moure, covered nearly 2 miles north and south, and were 10 to 12 feet deep. Now one is dry and the other nearly so.

Cottonwood Lake, 1 mile long and one-half mile wide, 9 miles southwest of La Moure, is now a shallow pond, 6 feet lower than five years ago. This is about all the surface water, except the James River, in the entire 1,152 square miles of the county.

The James River has been only a shadow of its former self most of the time the present season.

The disappearance of these sloughs and ponds has been gradual—less from year to year—in the face of the generally received theory that cultivation of the land increases rain-fall.

What is true of La Moure County in these respects is also true of nearly all the present occupied portion of the two Dakotas.

I. *Feasibility of an artesian-well system.*—Wells are now in operation scattered over 300 miles north and south and 200 miles east and west. Irrigation believed to be practicable to a large extent.

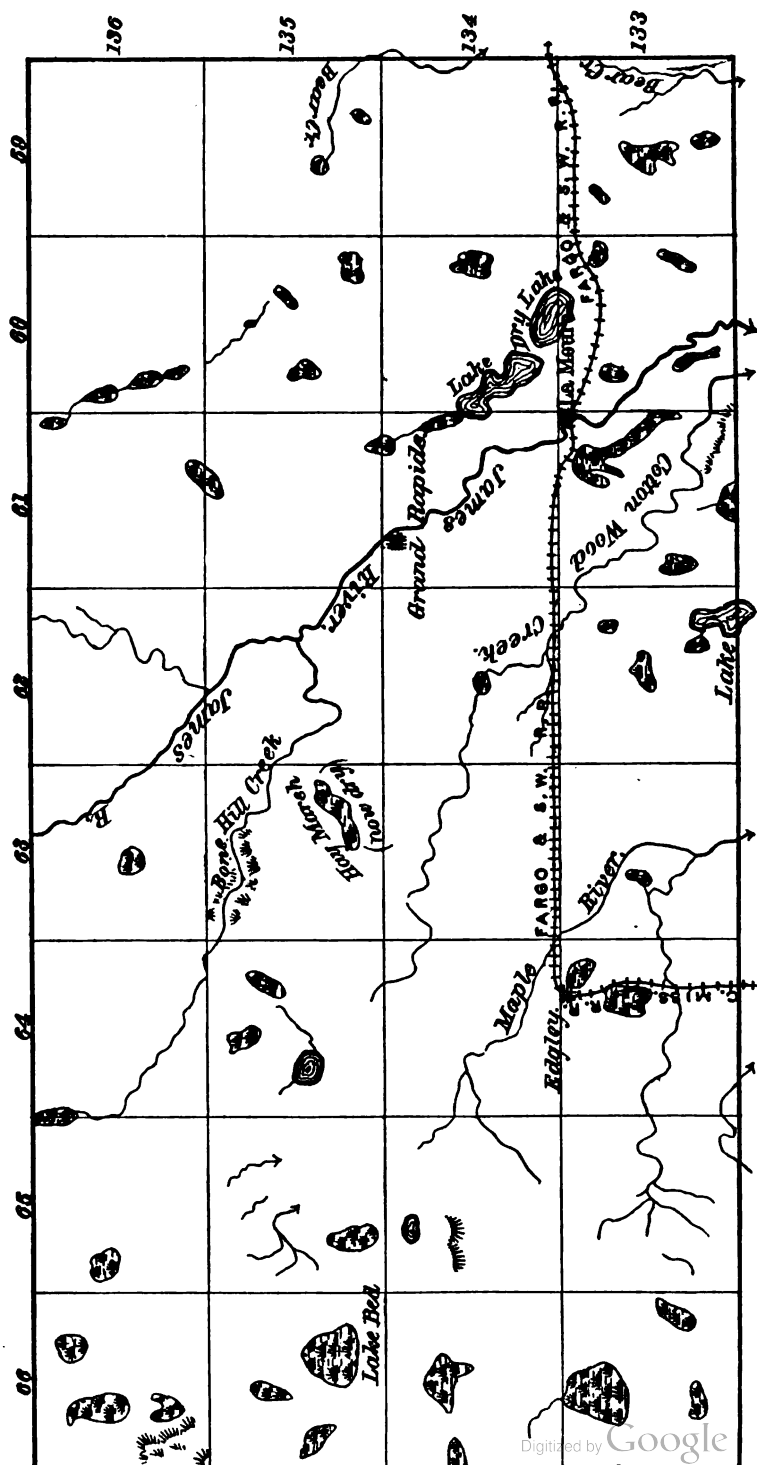
II. *Necessity.*—Seasonable rain-falls more uncertain, and growing less for a series of years. Drying up of water-courses, sloughs, and lakes. Deficient crops.

III. *Need of Government help.*—The bulk of Dakota people are poor; heavily in debt; lands, crops, and chattels mortgaged; result of decreasing crops and low prices. Bonding and taxation to inaugurate a system of artesian wells, with whatever risks there may be of success, would seriously burthen their resources.

IV. *The General Government should open the way.*—About \$20,000,000 already paid into the United States Treasury by Dakota settlers; 20,000,000 acres yet to be occupied, in addition to 10,000,000 expected from the Sioux Reservation. Better water supply necessary to encourage immigration. A return of 5 to 10 per cent. of what has been realized would suffice.

V. *Great natural fertility of the soil will justify the expenditure.*—Thirty to 40 bushels of wheat per acre have been raised in favorable seasons. For lack of moisture 10 bushels is all that can be expected this year, and thousands of acres have been plowed up. Irrigation would doubtless insure 30 to 50 bushels.

LA MOURE COUNTY, NORTH DAKOTA.



32 Congressional townships, 1152 square miles.

VI. Investments in Dakota show the courage, character, and enterprise of her people.—

Assessed valuation, 1888	\$161, 420, 974
South Dakota	\$91, 381, 072
North Dakota	\$70, 039, 902
Post-office revenues	\$500, 000
Expended for schools in 1888	\$1, 051, 327
Number of church societies	1, 000
Railroad facilities:	
North Dakota	 miles.. 2, 100
South Dakota	 do..... 2, 400
Aggregate banking capital	\$11, 747, 440

VII. As agriculture underlies all Dakota prosperity everything for the future depends upon its encouragement. With adequate water supply great prosperity is assured. Without it all is in peril.

RECEIPTS OF DAKOTA LAND OFFICES.

North Dakota.

Fargo	\$3, 257, 776
Grand Forks	2, 921, 000
Bismarck	640, 000
Devil's Lake	710, 624
	7, 529, 400

South Dakota.

Aberdeen	\$1, 867, 881
Yankton	1, 094, 944
Huron, Mitchell, Watertown, and Deadwood, estimated about \$10,000,000. Total, about \$20,000,000.	

COMMUNICATIONS FROM CITIZENS AND ARMY OFFICERS.

STATEMENT OF J. E. LABRIE, OF DOLAND.

DOLAND, DAK., July 23, 1889.

To Hon. Wm. Stewart, chairman, and others, of the United States Senate Committee on Irrigation, sitting at St. Paul, Minn.:

GENTLEMEN: The people of Spink County, Dak., comprising 1,512 square miles of land and containing 15,000 population, have suffered for four years from a shortage of crops on account of insufficient supply of moisture. We have an unfailing supply of water at a depth of from 900 to 1,000 feet below the surface, which rises through the artesian wells now in operation with a force of 200 pounds to the square inch; we have a country that is traversed by innumerable dry water-courses, and interspersed with numerous dry lake beds; we believe that if these water-courses and lake beds were filled from the subterranean fountains the evaporation would tend to produce more rain, heavier dews moisten the atmosphere and temper the hot south winds which destroy our crops; without artificial means for producing moisture we must struggle against failure; with artesian fountains feeding the dry water-courses and lake beds we are confident that we shall become the greatest grain and stock producing country on the continent; we believe that Dakota, robbed of a large portion of her school fund, long deprived of her political rights and with no hope of Government appropriations except in this direction, should be liberally dealt with on this question by Congress; we ask that Congress appropriate sufficient money to sink artesian wells along the James River Valley at the head of dry water-courses and lake beds so as to fill them with water.

To the end that the people of our county may obtain information on this subject, I have appointed the bearer, John J. Cushing, of Ashton, to wait upon you in conjunction with the committees from the other counties of the Territory.

I have the honor to be very respectfully,

J. E. LABRIE, JR.,
Chairman Board of County Commissioners, Spink County, Dak.

STATEMENT OF JOHN J. CUSHING, OF ASHTON, DAK.

The water question is creating a profound interest in our new State.

We have a soil equal, if not superior, to any in the United States for the production of all kinds of cereals, but the absence of sufficient rain-fall at the periods when most needed has become damaging to us, and from a production of 62,000,000 bushels of wheat in 1887 we declined to 37,000,000 in 1888, and according to a recent estimate of the commissioner of immigration we shall come down to about 20,000,000 bushels this year.

As the United States produces more wheat than it can consume, and we therefore are heavy exporters of wheat, seeking to become strong competitors of India and Russia in this branch of commerce, the loss to this country in a commercial sense on the shrinkage in this one commodity in the last two years has been nearly \$50,000,000.

Can the people of this Republic submit to a loss of \$25,000,000 annually in this one industry on the ground that an internal improvement to protect and build up the same would be local? Can the General Government fail to recognize that the improvement which we propose asking for will increase the production of wheat here in a comparatively short time from 20,000,000 to 100,000,000 bushels, and cheapen the cost of production correspondingly with the increase? With cheap land and plenty of moisture Dakota can compete with any country in the world in wheat raising.

We have the land and have paid the General Government many millions of dollars for it. This money is being used to deepen harbors and water-ways for, we might say, the local benefit of commercial centers; to build custom-houses and post-offices to suit the metropolitan architecture. May we not reasonably ask for a return of a portion of the money which we have so bountifully contributed?

Why this absence of rain-fall, and what remedy can we apply? That the absence of rain-fall is directly traceable to the absence of water-courses and lakes, and resulting surface evaporation in some portions of our State, I think may be established by careful examination of the meteorological reports of the different localities.

Taking the reports from July, 1874, to December, 1886, we find that the mean annual precipitation for the whole Territory, as established by the record of twenty-nine points of observation in all parts of the Territory, was 22.35 inches. This does not include a large portion of country west of the Missouri, where the rain-fall was light, and would have reduced the general average below 20 inches.

Out of the twenty-nine places fifteen fell below 20 inches, while fourteen were above that mark.

Taking the James River Valley, it being the most thickly settled portion of our Territory, as the subject for comparison, with Huron, Yankton, Alexander, and Webster as the points of observation, we find the mean annual precipitation during that period as follows: Huron, 23.65; Yankton, 23.43; Alexandria, 30.54; while at Webster it reached the amount of 44.61.

We have only to examine the map to furnish sufficient account for the increased precipitation of the other points over Huron. At Webster, where the greatest precipitation occurs, there are numerous small lakes furnishing the surface evaporation. At the other two points their location between the Missouri and Sioux Rivers furnish the explanation; while at Huron there is an absence of lakes or water-courses, and all places similarly located—which is the case with most points in the James River Valley—are similarly affected.

Let us examine the summer rain-fall. From April to September, both inclusive, at the same twenty-nine points, and over the same period, from 1873 to 1887, we find the mean average monthly rain-fall for the whole group to be: April, 2.50; May, 3.20; June, 3.64; July, 3.10; August, 2.65; September, 1.59. Sixteen points fall below the average for April; seventeen points fall below the average for May; sixteen points fall below the average for June; eighteen points fall below the average for July; fifteen points fall below the average for August; and eighteen points fall below the average for September.

Let us now examine the same four points in the James River Valley over the same period. We find the average rain-fall at each point for each month during the fifteen years was as follows:

Point.	Apr.	May.	June.	July.	Aug.	Sept.	Total.	Mean average monthly.
Huron.....	2.60	3.34	3.68	4.25	3.37	1.43	18.67	3.11
Yankton.....	3.25	4.24	4.42	3.71	3.05	2.93	21.60	3.60
Alexandria.....	3.46	3.47	4.20	5.28	3.20	1.18	21.37	3.56
Webster.....	4.87	6.18	7.24	6.30	2.53	3.18	30.30	5.05

The above shows the effect of surface evaporation on our rain-fall. Now if this will increase our rain-fall from an average of 3.11 to 5.05 inches per month, and our annual precipitation from 23.65 to 44.65 the benefits would be incalculable to our country. The effect would be beneficial to our climate, would enable us to grow trees, would swell the volume of the Missouri River, and make of the James a river of the first class below navigable.

How are we going to bring about this increased rain-fall? By creating lakes and streams throughout the entire length of the James River Valley, the evaporation from which will bring us the precipitation here and in the adjoining States.

We have underlying the whole valley a subterranean lake, fed from a fountain far above the level of the valley, which we believe is inexhaustible. The depth ranges from 600 to 1,500 feet, and when the fountain is tapped the water rises to a height of 100 feet and has a pressure of 175 pounds to the square inch. It is estimated that the amount of water flowing from a 6-inch well is 3,500 gallons per minute, or 210,000 per hour, or over 5,000,000 every twenty-four hours from one of these wells; it becomes, then, a mere matter of calculation to ascertain how many wells we need to fill up our lake beds and dry water courses.

I have here a map of Spink County, on which I have marked in red ink the dry lake beds and water courses in this county, from which it can be seen that with artesian wells at the head and along the water courses we should have as finely a watered county as could be found anywhere; the old lake beds would fill up, the water would percolate into the subsoil, and, coming out to the surface, would give us rains and dews. In this county, at Ashton, we have an artesian well; at Redfield we have one, and at Frankfort we have one.

The people of Dakota are enterprising and will do all they can to solve this question, but they are poor at this time and believe that Congress should take hold of the matter at once, without delay, and go so far as to sink large wells at the head of and along the dry water-courses and in the vicinity of dry lake beds.

It is not expected that Congress will go into the business of irrigation, but merely to fill up these old water courses as they originally were. The people of Dakota will then take hold and do the rest if wells are needed for mechanical or irrigation purposes.

How much is it going to cost the Government to do such work as we desire? It is estimated that these wells can be sunk for \$1,000 each. A sufficient number should be sunk to accomplish the end sought. If one hundred were required in each county in the artesian well belt of both North and South Dakota, it would require an appropriation of only \$4,000,000, but there are many counties where but few would be required. What we want is an appropriation of somewhere near that amount, placed at the disposal of the Bureau of Geological Survey at once, require that Bureau to proceed with all dispatch possible, and make a survey and sink such number of wells as shall be deemed necessary.

Can the Government afford to refuse so paltry a sum—equal only to about one-sixth of the amount lost every year to the country from a failure resulting from the absence of this improvement?

Gentlemen, we ask your aid in this matter; we ask you to come and see our beautiful country.

STATEMENT OF V. HAVARD, ASSISTANT SURGEON U. S. A.

The arid lands of the United States, especially those which form such a large part of our territory between the 100th meridian and the Sierra Nevada, may, for our purpose, be classed under two heads: Valleys, bottoms, and flats of alluvial formation and more or less capable of irrigation, and high plains or table lands where irrigation and therefore cultivation are out of question. The latter form the great bulk of the lands under consideration, and therefore the problem how to utilize them, how to make them productive, is one of very great interest. Their enormous extent is at once appreciated by realizing that they form the greater part of Texas, New Mexico, Indian Territory, Idaho, Utah, Nevada, and Southern California, with much of Wyoming, Colorado, Nebraska, and Dakota. These plains and table-lands are destitute of timber, and their treeless condition, giving them a bare, monotonous, and often dreary aspect, has fostered the impression that their soil does not contain the elements of vegetable life, an impression which has been demonstrated to be quite erroneous; it is in fact more or less fertile, and as a rule covered with herbaceous vegetation.

The treelessness of the western plains and prairies is due to causes in which the productive capacity of the soil is not involved. True, barren, irreclaimable sandy deserts are quite rare in the United States and of limited extent. Thus Dr. Sereno

Watson, in his classic work on the botany of the Great Basin of Utah, the worst part of the American Desert, says: "No portion of this whole district, however desert in repute and in fact, is destitute of some amount of vegetation, even in the driest seasons, excepting only the alkali flats, which are usually of quite limited extent. Even these have frequently a scattered growth of *Sarcobatus* or *Halostachys* surmounting isolated hillocks of drifted sand, compacted by their roots and buried branches. It has often been noticed that sandy tracts of most unpromising aspect showed unexpected fertility under the action of water.

The prairies of Dakota, Nebraska, and Montana are famous for their nutritious and self-curing grasses, which form a close and continuous sod. West of the Rocky Mountains the conditions of vegetable life are less favorable (greater heat and smaller rain-fall); the grasses seldom form an unbroken sod, but generally grow in isolated bunches. Here, says Prof. J. T. Rothrock, "the indigenous grasses, though somewhat localized in their distribution and seldom forming a dense sward, are exceedingly nutritious, and stock will make long marches, having no other food. Among them we may specially allude to the various 'bunch grasses' of Colorado, i. e., *Eriocoma*, *Festuca*, and *Poa*, and more notably still the *Boutelouas* of southern Arizona, where without much distinction all are called 'Grama.'

"The staked plains of Texas and New Mexico, which have been so often described as dreary expanses of sand, are mostly covered with excellent grass, and in places are fast becoming well stocked with cattle and sheep. At one station in the southern staked plains (less fertile than the northern) I observed nine species of grasses, including four of Grama, round about our camp."

Utah is not a promising agricultural land. There no crop is possible, except with irrigation, and pasturage is confined to the mountains. Yet the well-known botanist, Marcus E. Jones, expresses himself with some enthusiasm about the potential fertility of that Territory: "If Utah has had such a luxuriant flora in times past, and now possesses so many beautiful and useful plants where there is sufficient moisture to support them, what is to hinder its becoming a paradise again? Nothing but water. The soil is rich, and the climate is magnificent—unexcelled in this country. The cañons supply much water, and have wrought great changes in the appearance of many valleys. There is scarcely an alkaline flat or plain in Utah that does not have a natural reservoir beneath it of sweet water, ready to flow the moment it is tapped. The time is not far off when the bed of the ancient lake from one end of Utah to the other will be covered with waving grain and groves of thrifty fruit trees."

The foregoing remarks tend to show that the so-called arid lands (plains and mesas) of the "Great American Desert" are not sterile. By far the larger proportion produce grass of excellent quality. They form vast natural pastures, which under proper management are capable of subsisting herds of stock vastly outnumbering the former legions of the now extinct buffalo. All they need is water; truly an imperative need, but not beyond the reach of well-directed energy. One may travel day after day in western Texas, New Mexico, and Arizona over plains and mesas carpeted with fine and nutritious grass, which, as is well known, cures itself and retains its qualities throughout the winter; yet, owing to the absence of springs, streams, or wells, this grass is entirely inaccessible and unavailable to cattle and sheep. Drinking water for stock is then the great desideratum. We may assume that there is a sufficient rain-fall over the territory in question for the supply of all the stock which the available grass can support. It ranges, I should estimate, from 10 to 25 inches annually.

Rain falling upon uncultivated soil, especially if covered with a dense sod, as in the prairie States and Territories, does not penetrate to any amount into the subsoil, but runs off into ravines, arroyos, and cañons, and is soon drained away; stream-beds ordinarily dry become raging torrents, which soon again subside, and the much-needed water has passed away and is practically lost. It is an interesting fact worthy of note, that under such conditions—namely, scant rain-fall and slight penetration—the grass should grow so well, often so luxuriantly.

If the surface crust be broken up and the soil cultivated more or less deeply, then the rain penetrates with facility to the subsoil where it is held in reserve, and the farmer is surprised at his ability to raise crops where the apparent aridity of land and climate had long delayed the trial of cultivation. From this fact of the greater usefulness and availability of rain falling upon tilled soil has arisen the belief generally entertained in the West, that the yearly rain-fall has increased of late. Careful comparison of statistics by competent observers has shown that there has been no such increase; if any, it is very slight, and more rationally accounted for by the greater care in collecting and measuring now exercised by the Signal Corps.

From what precedes it is not to be inferred that rain-fall with cultivation is sufficient to make farming remunerative over much of the "arid lands." Such farming, without irrigation, is, west of the Missouri River, fairly successful in Dakota, Montana, and Wyoming, but entirely precluded west of the mountains.

The question arises how the water required for stock on the prairies, plains and

table-lands of the "American Desert" is to be procured. In two ways: By wells and by reservoirs. Wells must overflow (artesian wells), or else the water must be pumped. Artesian wells are common in some of the basins of California, Utah, etc., but hardly to be expected on high lands, where water is most needed; there we must depend upon wells from which the water is pumped. The trials made in sinking wells upon many districts of the "arid lands" have been encouraging; wells are bored and good water struck at variable depths in many unlikely places. Thus, where the Texas Pacific Railroad crosses the Staked Plains an abundance of good water was obtained at several stations within 40 or 50 feet of the surface. On the contrary, at Marfa, Tex., a station of the Southern Pacific Railroad, standing in the midst of immense level prairies, a "drive" well had to be sunk to the depth of 1,200 feet before good and abundant water could be obtained. This well now supplies not only the railroad locomotives, but also the whole town, which is a flourishing county seat. "Striking" water under these circumstances is mainly a question of depth, which in its turn is governed by that of expense. As wind of various degrees of velocity is always blowing over the Western plains, wind-mills will afford a certain, cheap, and efficient motor to work the pumps.

Reservoirs in the shape of tanks or lakes are for the purpose of collecting and retaining rain-water; their establishment is simply a question of expense, and is, I think, practicable almost everywhere. However level a plain or prairie seems to be, it is always scarred by gullies and ravines leading to stream beds, and it is in these ravines or in the valleys into which they open that the tanks or lakes should be constructed. In hilly or mountainous regions advantage should be taken of cañons or other natural reservoirs. There, and wherever practicable, the tanks should be in twos, that is, each collecting tank should have a corresponding tank at a lower level; the rain-water is collected in the first, and later, as it becomes clear, decanted by a system of sluices into the lower.

The many streams, large and small, which drain the arid country between the 100th meridian and the Sierra Nevada are characterized by great width of alluvial bottom and the crookedness of their ever-changing channels—necessary peculiarities of streams which overflow with each rainy season and always hold a large proportion of earthy matter in suspension.

As already stated, the rain, unable to penetrate the hard crust of uncultivated soil, is shed off, carrying with it whatever soil it succeeds in detaching and disintegrating; the result follows that all the streams of the "American Desert" are yellow or red with mineral matter held in suspension. The Rio Grande, immediately above its junction with its main tributary, the Rio Conchas, rolls liquid mud in summer, and is some-times designated with justice, Rio Puerco. The many Rio Colorados or Red Rivers of that region testify by their name to the same fact.

Much of this suspended matter is deposited along the course of the streams, and gradually adds to the width and depth of the valley bottoms. These bottoms are formed at several levels; some are periodically covered by high water, others are only flooded in exceptional years, and still others have never been covered within the memory of old settlers. Their fertility is very great and well-nigh inexhaustible. The lower bottoms often yield abundantly without irrigation, the spring overflow, if not too violent, being taken advantage of to start the crops and fertilize the ground.

Irrigation gives agriculture the degree of certainty and exactness of a scientific industry. The farmer reaps as he sows, in accordance with his labor and his skill; he is no longer dependent on the amount and distribution of the rain-fall, and a prolonged drought will only give the more value to his assured crops. He, however, avails himself of whatever rain may fall, bearing in mind that rain-water contains fertilizing elements often wanting in river-water.

In a warm climate, such as that of most of our "arid lands," with an abundant supply of water on good soil, the processes of vegetable life are exceedingly active, so that growth is rapid, and several successive crops are possible during the same year. It is a fair general estimate that irrigated land produces twice as much as the same quality of land in a region where rain-fall is deemed sufficient.

The only navigable rivers which to a slight extent penetrate the "American Desert" are the Rio Colorado, the Upper Missouri, and the Yellowstone. Since the advent of railroads navigation has practically ceased on these streams, so that, as far as it is concerned, it would not matter to what extent their tributaries or their own waters were directed from their courses for the purpose of irrigation. As a matter of fact, however, most of the water thus used in irrigation finds its way back to the river-beds, so that streams show but little, if any, diminution of volume; it follows that not only is navigation not endangered, but the water supply of the populations settled below the irrigated area is not practically diminished.

Most of our Western rivers have periods of overflow, but, unlike that of the Nile, this overflow is too irregular as to duration and extent to turn it to practical advantage on any large scale. It is utilized on the Upper Rio Grande and on the Lower Colorado, and it may be that, by the proper construction of ditches and dikes, its utilization could be very much extended.

Irrigation is only applicable to valleys and connecting bottoms or flats. The water is generally derived from the main stream or its tributaries, dammed or not, as the case may require. It often happens that the tributaries have a greater slope than the main stream, so that their waters can be made to reach the desired point at much less cost. Water can also be derived, but necessarily on a small scale, from artesian wells and springs. It would also be possible, specially in mountain districts, to irrigate from tanks or artificial lakes built in cañons or ravines, wherein water from rain or small streams is collected. For purposes of irrigation mountain streams are particularly advantageous, as their waters can be utilized in the valleys on which they debouch with very little work. In this connection, attention should be called to the great value of timber on the mountains which feed such streams. Whether timber increases the rain-fall is uncertain, but there is no doubt as to its beneficial effect in retaining the precipitation and equalizing its outflow, so that throughout the year the streams run with an even, steady current, seldom becoming raging torrents and never entirely dry.

The adaptability of rivers to irrigation depends very much, other things being equal, upon their rate of fall; thus, the Missouri falls less than a foot per mile, the Yellowstone $1\frac{1}{2}$ feet, while the Rio Grande falls nearly 3 feet per mile. It follows that the difficulties to overcome in using the waters of the Rio Grande are much less than would be met in tapping the former streams. We find irrigation commonly practiced along the Rio Grande and on many of its tributaries, while it has hardly been begun on the Yellowstone, and is probably impossible on the Missouri.

From observations made at my last station (Fort A. Lincoln, Dak.), and my present one (Fort Buford, Dak.), I am able to offer a few remarks on the practicability of irrigation on the Upper Missouri and the Yellowstone.

The valley of the Upper Missouri is bounded by two lines of bluffs, and the river runs its tortuous course between them, washing the base of the bluffs alternately on one side and the other, so that large areas of irrigable alluvial bottom-land are seldom seen. The length of the "bottoms" inclosed in the turns of the river seldom exceed a mile or two; therefore, a canal of several miles in length would have to be raised over the high banks of the bluffs.

I have computed (taking Lewis and Clark's estimate of distance), that the fall of the Missouri River between the mouth of the Yellowstone down to Omaha is almost exactly three-quarters of a foot (.76) per mile. The minimum height of irrigable land above the river level (at low water when irrigation is most needful) is 12 feet, therefore a canal of at least 16 miles would be required if it followed the curves of the river, and only 10 or 11 miles if perfectly straight. In practice, we may say (making allowance for fall) that on the Missouri, any irrigating canal will be at least as many miles in length as the land to be irrigated is feet above the water level. As few irrigable bottoms have a greater area than 1 or 2 square miles, it would seem very unprofitable (even supposing there were no serious obstacles to overcome) to dig a canal of such great length for the accomplishment of such small result. We must also bear in mind the great rise and fall of the Missouri, causing a difference of level of at least 15 feet, and it will be safe to conclude that the irrigation of the Missouri Valley by means of canals tapping the river is out of question, even with the most liberal aid from the Government.

The only practicable way, in my opinion, in which the many alluvial bottoms of the Missouri could have the benefit of irrigation is by means of pumps and tanks, the pumps to be worked by steam or wind. One wind-mill and tank would easily supply all the water required for the irrigation of several hundred acres of land.

The current of the Yellowstone is much more rapid than that of the Missouri. Between Glendive and the mouth of the river, at Fort Buford, the fall is $1\frac{1}{2}$ feet per mile, more than double that of the Missouri. Above Glendive, the fall is still greater and much land could doubtless be profitably brought under irrigation either from the main stream or some of its tributaries. Work is now in progress to bring the waters of Tongue River to the flats of Miles City.

The Lower Yellowstone Valley is bounded by bluffs on the east side, but is broadly open on the west side, where it extends up-stream for many miles uninterruptedly, and here is an exceptional opportunity for the application of irrigation on a large scale. It is estimated that the available lands for the purpose range from 1 to 4 miles in width for a distance of 30 or 40 miles above the mouth of the river. These lands are from 8 to 30 feet above the average stage of water, and not subject to overflow; the lower (those nearest the river) are covered with scattered clumps of cottonwood and willow, and almost always by the characteristic gray sage-brush of this region (*Artemisia cana*), which is indicative of a rich soil; the higher are prairies already occupied by many settlers, and in propitious years yielding fair crops under cultivation.

The Yellowstone is not subject to the same extreme rises and falls as the Missouri, and therefore its average level is more constant. I estimate that the length of canal required to bring water upon the above lands, so as to make it available from a point

35 miles above the mouth of the river, would be from 12 to 15 miles. Thence down to the mouth the canal would follow the natural slope of the valley along the upper edge of the lands supplied. There are but few obstacles to overcome, yet such a large enterprise, it is needless to say, can only be undertaken by a company with large means and with liberal Government aid.

To conclude, we may ask in what particular lines should Government help and intervention be specially directed so as to be most effectual. These, in my judgment, are as follows:

1st. In thoroughly and immediately protecting the forests now remaining upon all national lands, with a view to the continued usefulness of the streams fed by those lands.

2d. In investigating the number of mountain streams which can be canalized or dammed; to what extent and in what manner, so as to make them available in arid valleys and basins.

3d. In determining the depth at which water in all the districts of the American Desert can be obtained.

STATEMENT OF ARTHUR WILLIAMS, FIRST LEUTENANT THIRD INFANTRY, U. S. ARMY, FORT MEADE, DAK.

In a full sense, the term arid lands embraces not only true deserts and tracts which depend absolutely on irrigation for the production of crops, but also lands on which, in the absence of irrigation, the crops would be in danger of being lost or impaired. The definition of arid lands given in our statutes (Sec. 2, act March 3, 1877), therefore, does not include all arid lands. For instance, the grain crops in Bare Butte Valley, Dakota (near Fort Meade), in absence of irrigation, are liable to failure from drouth one year out of five, while with irrigation crops of the cereals, superior in quantity and quality to the best that can be produced with the natural supply of water, are, barring hail, almost certain. I am credibly informed that in some cases settlers who have attempted to locate in this vicinity, and who had no facility for irrigation, have become discouraged by failure of crops, and have abandoned their claims.

The accompanying table compiled from the records of the Post hospital at Fort Meade, to which, through the kindness of Dr. W. C. Shannon, Post surgeon, I have had access, exhibits the rain-fall in this section during the past five years:

	1884-'85.	1885-'86.	1886-'87.	1887-'88.	1888-'89.
	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
May.....	8.58	.64	.57	2.72	4.14
June.....	.48	3.39	.45	1.76	5.50
July.....	1.20	1.52	3.68	4.46	2.64
August.....	2.30	8.22	1.50	4.25	3.70
September.....	.23	.28	.40	1.10	.00
October.....	.96	.74	.40	.40	.25
November.....	.53	.42	1.60	.24	.16
December.....	.80	.17	.72	.36	.17
January.....	.32	.32	.56	.00	.29
February.....	.23	.67	.20	1.20	.85
March.....	.62	.88	.76	.75	.12
April.....	1.22	2.17	2.12	.10	2.64
Total.....	17.43	14.42	12.96	17.43	20.46

Average annual rain-fall 16.55 inches.

The deficiency of precipitation in the months of June and July, 1884, will be noted, also that in the month of May of that year over one-half of the average rain-fall of the section occurred.

It is, I believe, well established that most soils when supplied with a sufficiency of moisture, provided the thermal conditions are not unfavorable, may be made to produce agricultural crops. Even the volcanic ashes of *Ætna* are planted with vines to a height of 3,000 feet, and the sands and gravel of portions of the Sahara have become fruitful on being watered from artesian wells. (The Earth Modified by Human Action; G. P. Marsh, pages 150 and 481.)

Assuming that most of the arid lands of the United States can be reclaimed and rendered valuable for agricultural purposes, provided they can be watered, it remains to be considered how the necessary water is to be obtained.

By statute, the "waters of all lakes, rivers, and other sources of water supply upon the public lands, and not navigable, shall remain and be held free for the appropriation of the public for irrigation, mining, and manufacturing purposes, subject to existing rights." (Sec. 1, act March 3, 1877.) These, together with the waters that can be withdrawn from beneath the surface or from the atmosphere, constitute the fund available.

The bad lands and other such broken and forbidding surfaces, it would seem, can never be put to any agricultural use, except perhaps grazing, yet by the use of wells, storing of rain and snow-waters in gorges, etc., sufficient water might be obtained in places to render the cultivation of garden vegetables and small fruits practicable and to promote the growth of grasses. Experiments could easily be made by the Government, and might be repaid with unexpected and good results.

Such deserts as are not only deficient in rain-fall, but also have no streams running into or through them, present great difficulty. If they occupy a sufficiently low level, as in the case of the Colorado desert, water may be introduced from the ocean bed or lakes, or the whole or a portion of a river may be diverted into it, or the conditions may be favorable for obtaining water from artesian or ordinary wells. By the introduction of ocean waters the result would be attained indirectly, the idea being to provide the agricultural water by means of evaporation and subsequent precipitation from the atmosphere. Such a project is necessarily in the nature of an experiment; much more so, I think, than is the sinking of artesian wells. From the character and magnitude of all of the enterprises named I believe engineering experts should determine the best course to be pursued.

When the areas to be watered occupy a high level, water, if obtained at all, must be raised from streams or lakes by mechanical appliances or be drawn from artesian wells. Here, too, engineering skill and judgment will be required.

Where, as in portions of California and Nevada, streams of considerable size sink in sand or gravel, it may be advisable to construct artificial channels to keep the water on and conduct it over the surface; or perhaps ordinary or artesian wells can be employed to advantage. Here, again, engineering investigation should determine the best method of accomplishing the desired object.

The simplest form of irrigation is that of conducting water from streams by means of ditches, a dam of some kind being usually constructed to increase the "head" of water. This is the method generally resorted to in reclaiming lands under the act of 1877.

The manner of applying water to crops is a subject which, I understand, it is not intended I should touch upon. The Department of Agriculture, through its skilled agents, is well fitted to suggest the best methods, depending on the character of the surface, nature of the soil and of crops, the peculiar meteorological conditions, etc.; and farmers will be led by self-interest to avail themselves of such valuable assistance.

In many instances, I think, the manner in which water is appropriated is open to objection. When one or more settlers find a small stream emerging from the hills, and so conduct it that the entire body of water can at any time be made useful, it would seem that nothing better could be done. Still, if the demand is not for a continuous and full supply of water, but only a supply at a particular season, or a variable supply, unless reservoirs are employed to be drawn from according to actual needs there will be waste, inasmuch as by judicious storing a larger area could be benefited.

Whenever the whole or a portion of any stream is diverted, there is a liability to waste, although the fact may not be suspected by the persons appropriating the water. Moreover, the distance from which water must ordinarily be conveyed, in order to bring it to the level of the land to be irrigated, renders ditching costly. Individual settlers, if poor, frequently find it impossible to secure a supply of water, and when settlers along a valley unite in making a water-ditch for the common benefit bickerings and disputes are liable to arise and even where accord exists, it can hardly be expected that any effort will be made to benefit any but the best and first selected lands. The fact also must be kept in view that selfish interests operate to induce avaricious settlers to make it difficult for their poorer neighbors to improve their lands, so that they may be willing to part with them at a low price. I believe it would be good policy for the Government to construct the main irrigating ditches in all valleys of considerable size; for example, in the valley of the Big Horn in Montana. It would be a matter of engineering to determine the points from which water should be taken, and to locate ditches where they would do the most good.

There is another matter which I think of importance:

In all portions of the United States there is some rain-fall. The annual precipitation varies according to reports from a very few inches in the Colorado region to the extreme of several feet in other portions of the country. We have therefore to deal with all conditions, from that of almost absolute aridity to that of almost excessive humidity. Moreover places with the same average annual precipitation may vary greatly as to the general laws controlling its distribution throughout the year.

Further, the peculiarities of surface—flat, sloping, basin-like, etc., nature of the soil and subsoil—whether absorbent or otherwise, chemical characteristics, the depth of impervious strata, the action of dry or moist winds, and meteorological conditions generally, as well as differences of altitude and latitude, produce effects which greatly modify the results obtained from the same amount of precipitated moisture, although similarly distributed.

It may therefore be necessary in some sections to provide for irrigation throughout the whole year; in others during certain seasons only. In some places a small but regular supply of irrigating water is demanded; in other places a large supply for a very brief period may suffice. I believe it may be safely stated as a general rule that in sections where irrigation is advisable, economy of water-supply is absolutely necessary.

Even where large rivers are available as a source of water supply, if a larger quantity is diverted into canals or ditches than is necessary to supply the area to be watered, the volume in the river channel proper is unduly diminished. The trees, if there be any along the margins, will languish or die. The local evaporation will be much greater, owing to increased surface and diminished velocity of the waters, and although it is true that the diverted waters will, for the most part, be restored to the valley by drainage and the precipitation of the evaporated moisture, there is in such cases almost a certainty that some districts will be benefited at the expense of others. This objection is made more significant when the waters of the stream are needed for other than agricultural purposes.

In the case of small streams, where the supply is either irregular or intermittent, or where the demand is transitory, it is, I think, apparent that a treasuring up of the water in suitably situated reservoirs, from which it can be distributed according to requirements, would be useful.

By means of such reservoirs very considerable areas might be benefited; whereas if the waters are not stored they may be insufficient for any useful purpose. It might also be well to consider whether the waters accumulating from rains and melted snows in gorges among hills and mountains might, if held in reservoirs, be made useful for irrigation.

I am of opinion that reservoirs in connection not only with flowing (artesian) wells, but also in connection with water pumped by means of wind-engines from ordinary wells and low surface waters, will ere long become an important factor in irrigation.

Wells as a means of irrigation deserve, I think, more attention than they have yet received in this country. Artesian borings undertaken by the Government have been few in number, and although they are becoming numerous in connection with other industries they have as yet received scarcely any notice in agriculture. That they would prove useful in irrigation is scarcely doubtful, judging from the success that has attended their use by the French Government in Algeria. The cost of sinking such wells, combined with the doubts that exist as to their proving successful, has thus far deterred individual enterprise. In some localities which are deficient in rain-fall at certain critical seasons, ordinary well-water can be reached at moderate depths. Where it can be so obtained in sufficient abundance it might be pumped by means of wind-engines, which have been brought to a high degree of perfection and which can be obtained at a moderate cost, and stored in reservoirs for use when needed. This method is open to individual enterprise.

Besides, by furnishing water directly to it, the wants of the soil might be supplied in a measure, and a very material one, by decreasing evaporation and inducing atmospheric precipitation. Two ways by which evaporation may be diminished deserve special attention; the first the use of wind-breaks, the second extraordinarily deep ploughing.

The arid and semi-arid regions are as a rule treeless and exposed to the sweep of dry winds, and from the effect of radiation of heat, combined with other causes, these winds are of constant occurrence. They gather up the moisture from the soil and growing plants very rapidly. The planting of trees and of hedges is undoubtedly the best means of providing wind-breaks. Wherever irrigation ditches are employed trees and hedges should be planted near them.

Deep plowing is an agency for preserving moisture in the soil which, I think, is not sufficiently understood, and consequently is not fully appreciated. Where it is resorted to the rains and snows that fall sink beneath the surface and are held there, as if in a reservoir, to be drawn upon when most needed. Farmers who have tried deep plowing in this section are advocates of it as a safeguard against the effects of drought.

With regard to inducing precipitation, I believe that although trees may not actually increase the amount of rain-fall, they assist in its equable distribution. By means of their foliage they discharge into the atmosphere moisture drawn from lower depths than are reached by agricultural crops. They thus supply what might otherwise be claimed and taken from the tilled areas.

The whole subject of irrigation is one of such national importance that I believe it,

together with the kindred and equally important one of forestry, should be under Government control and supervision. As many as possible of the citizens of the United States should own a portion of land in fee. Attachment to the soil is one of the best guaranties of patriotism. If wealthy individuals or corporations be the only ones who can successfully provide means of irrigation, large portions of the public lands that should furnish homes for hundreds—perhaps thousands—will sooner or later be monopolized. Should unskillful or wasteful methods of irrigation be adopted the agricultural area and population will be less than they should be, and the national wealth will be curtailed.

The streams and lakes, together with the subterranean and aerial waters, which belong to the public, are proper subjects for national control, and in my opinion should not, by any legislation or lack of legislation, be permitted to fall into the hands of monopolies. The farmer should not be compelled to purchase his water supply from either individuals or corporations, as is the habit among miners. It seems to me that the Government could easily take the whole matter of irrigation into its own hands, have engineering skill determine the best methods for the different localities, construct the canals, ditches, and reservoirs, sink artesian wells, plant and maintain trees for public use, etc. The appropriation of public money for the improvement of the public lands, it seems to me, would be as wise an expenditure as that for the improvement of rivers and harbors. Besides, the cost of such improvements could be refunded to the public treasury by charging an increased price for the land; or, indeed, a small charge might be made to farmers for use of water, in order to defray the expense of construction and maintenance of the means of supply, which would be cheerfully paid.

STATEMENT OF GEORGE W. H. STOUCH, CAPTAIN THIRD INFANTRY, U. S. ARMY, FORT SNELLING, MINN.

My knowledge of the matter is only general, such as one would obtain in casual observation during service in the West. While so serving, particularly in south-western Kansas during the years from 1866 to 1871, I found that as soon as work on new railroad lines commenced and settlements which followed sprang up, great climatic changes took place; rains followed the plowing of the ground and planting of trees. Later on, in traveling over country which, during my service there, was almost arid and sterile, I found vegetation well developed, and settlers raising corn and grain in abundance without artificial irrigation.

During my service in Montana, from 1877 to 1888, I found similar climatic changes followed the construction of railroads; and the turning up of the ground by the farmer's plow. Irrigation here, however, was generally resorted to, and large valleys apparently sterile were made to produce the best of crops by the use of the water from the numerous mountain streams in that country. In this manner a large part of the water in the creeks and rivers was taken from its natural course, spread over the cultivated tracts and evaporated. This appeared to increase the rain-fall and it was apparent that the shower region, which when I first went to Montana extended only along the heavily wooded mountain ridges, gradually descended lower until it was common to have abundant showers in the valleys along the water courses. During two seasons in the fertile Bitter Root Valley in Montana, good crops were raised consequently, with but little artificial irrigation; and lands along the foot-hills, a few years before considered worthless, are broken now and sown in wheat. I believe that all of our arid lands can be reclaimed by settlement.

The committee adjourned to meet at call of chairman.

SOUTH DAKOTA DIVISION.

SIoux FALLS, S. DAK., *August 2, 1889.*

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman) and Reagan, also Director Powell.

The CHAIRMAN. The committee is here for the purpose of obtaining information. We wish to know how the farmers are situated in this country with regard to a supply of moisture for agricultural purposes, what the deficiency is in that respect, what means they have of supplying that deficiency, whether by artesian wells, the storing of water, taking out of rivers, etc. We would like to have gentlemen now here from all sections of the State make statements covering the situation in their localities.

STATEMENT OF C. B. WESCOTT, OF DEUEL COUNTY.

Mr. Chairman and gentlemen: In the northeast corner of the proposed new State of South Dakota we have many lakes scattered here and there. Our rain-fall is from 22 to 25 inches during the year. On account of these lakes, as we believe, there is a little more evaporation and rain-fall. In the southern part of Grant County, the adjoining county on the north, they have artesian wells at 42 feet deep. There the water has flowed above the ground $1\frac{1}{2}$ feet. I think that can be indefinitely increased. These wells are thought to be fed by waters that gather in the Coteaux range, 4 or 5 miles south. As you go further from these coteaux or hills the depth at which you find water is greater, 125 feet, and rising above the ground to about the same height.

The CHAIRMAN. How is it with regard to the lakes? On what stream are they; into what do they discharge?

Mr. WESCOTT. Into the Sioux River. A great portion of the year they are entirely hemmed in by land. This season there has been no outflow at all.

The CHAIRMAN. Do they dry up in the summer?

Mr. WESCOTT. No.

The CHAIRMAN. Is there any water in them now?

Mr. WESCOTT. Yes.

The CHAIRMAN. The practical way would be to lower the lake and build a dam, and thus increase the amount of water.

Mr. WESCOTT. That could be done to some extent, but the banks are so low it can not be increased a great deal.

The CHAIRMAN. What do you mean by that?

Mr. WESCOTT. I mean that the ditch which drains the water at this point is so wide that a dam could not be built.

The CHAIRMAN. You could build an embankment upon it to some extent, could you not?

Mr. WESCOTT. Yes.

The CHAIRMAN. A dam a few feet high, if you have surface, makes a good deal of water.

Mr. WESCOTT. Yes ; that is true.

The CHAIRMAN. Are there a good many lakes emptying into the Sioux River ?

Mr. WESCOTT. In my vicinity there are six ; in Grant County, just beyond, they have quite large lakes.

The CHAIRMAN. And they all empty into the Sioux River ?

Mr. WESCOTT. Lake Kampeska empties into the Sioux.

The CHAIRMAN. What amount of area is covered by these lakes that form the source of the Sioux ?

Mr. WESCOTT. I do not know.

The CHAIRMAN. Do you know the amount of water-shed that supplies the lakes ?

Mr. WESCOTT. No.

The CHAIRMAN. There has not been any attention given to that subject ?

Mr. WESCOTT. They may have been, but not within my knowledge.

The CHAIRMAN. You do not need much irrigation where you live ?

Mr. WESCOTT. We have not suffered as they have in some other parts of Dakota.

Senator REAGAN. What is the distance from the bed of those lakes to the river ?

Mr. WESCOTT. One hundred miles.

Senator REAGAN. How far would you have to descend the river before you would come to a channel where a large body of water might be collected ?

Mr. WESCOTT. Not more than 15 or 18 miles before you would strike a large body of water.

Senator REAGAN. Have you any idea of the relative elevation of that country and this ?

Mr. WESCOTT. In my vicinity it is 175 feet higher. It is 1,900 feet above Lake Michigan in my part of the county ; but what it is right east I can not say.

STATEMENT OF WILLIAM COOK, OF MARSHALL COUNTY.

Mr. Chairman and gentlemen : I am from the northeastern part of the Territory. There are no lakes in our county, but we have some artesian wells there. There are lakes east of us, on the Indian reservation, and Marshall County is partly in it.

The CHAIRMAN. Have you suffered any from drought ?

Mr. COOK. We have not very much until this year. We have usually rain enough during the season, if it could be regulated—if we could get it at the right time of the year. But the showers are local. Some parts of the county suffer from drought while other parts have rain. In the eastern part of the county it is hilly, and the lakes are in near proximity. There they do not appear to suffer from drought as they do in the valley.

The CHAIRMAN. Have you done any irrigating in that part of the county ?

Mr. COOK. No, none at all.

The CHAIRMAN. Then you do not know what effect it would have to turn the water onto the land in that section ?

Mr. COOK. No, I do not.

The CHAIRMAN. You have not seen any experiments tried in that direction ?

Mr. COOK. No.

Senator REAGAN. Have you any artesian wells in your part of the State?

Mr. COOK. Yes; two in our county, and in Brown County several.

Senator REAGAN. Of what depth?

Mr. COOK. From 700 to 1,200 feet, I believe.

The CHAIRMAN. Do they discharge a good deal of water?

Mr. COOK. Yes; from 25 to 200 pounds pressure.

Senator REAGAN. Are you informed as to the cost of constructing an artesian well?

Mr. COOK. No, I am not prepared to speak on that point—to know just what the cost of a well would be. The cost of one of the wells there and the laying of the mains, a well a thousand feet deep, was \$4,000.

STATEMENT OF C. A. HOULTON, OF DOUGLAS COUNTY.

The CHAIRMAN. In what part of the State is Douglas County?

Mr. HOULTON. In the southeastern part.

The CHAIRMAN. Have you suffered any from drought there?

Mr. HOULTON. Yes; we think we have.

The CHAIRMAN. What streams are in your county?

Mr. HOULTON. There is a small stream that runs through our county called Choteau Creek.

The CHAIRMAN. How is Choteau Creek supplied?

Mr. HOULTON. This year we have not had running water any time during the season until the last rain, no water running in that creek until last fall. It usually rains in the spring until the latter part of June.

The CHAIRMAN. Is there any river in your county from which you could take water over your land?

Mr. HOULTON. I do not think there is any short of the Missouri.

The CHAIRMAN. The Missouri would have to be taken out some ways above to take your county in. But you all suppose that to be an impossible enterprise.

Mr. HOULTON. Yes; for the people in Douglas County it would be.

The CHAIRMAN. I am speaking of it as an engineering enterprise. I do not suppose you people would be able to do it now. Have you tried artesian wells in your county?

Mr. HOULTON. There are none there.

The CHAIRMAN. How much have you suffered this year; to what extent have the crops suffered; what proportion raised a good crop?

Mr. HOULTON. Take the grass, and it does not amount to anything this year; take the small grain, and it will probably be from a third to a half crop throughout the county.

The CHAIRMAN. I understand from the papers you passed a memorial asking for assistance in sinking artesian wells; you had some discussion on the passage of that memorial, did you not?

Mr. H. W. EDDY. Yes.

The CHAIRMAN. Was there a discussion of the reasons for presenting the memorial?

Mr. EDDY. It was not necessary for that, for we all knew them without discussion; each one understands just what the other thinks about that matter. This memorial was gotten up among ourselves, and it was not necessary to discuss the reasons for it.

Mr. HOULTON (continuing). If there were a line of artesian wells across the county we feel it would give us more rain-fall. There are two creek beds running across the county from north to south; the east creek is east of the center and the other west of the center, and they run parallel.

The CHAIRMAN. They do not rise in any flats or lakes?

Mr. HOULTON. No; nothing but rolling hills.

The CHAIRMAN. Have you a dam there?

Mr. HOULTON. There is a reservoir to hold water in the creek.

The CHAIRMAN. In a short creek you can not store much water; you want flat land, and then your dam produces some effect. But my experience is that in the tops of the mountains there are lakes where the water can be kept back; but yours are short creeks.

Mr. HOULTON. They are 20 miles long.

The CHAIRMAN. Your idea is that there should be artesian wells at the head to supply them with more water.

Mr. HOULTON. That is my idea.

The CHAIRMAN. You have not taken out any water to test what you could do by irrigation?

Mr. HOULTON. There is none to take out; when we need irrigation there is no water in the creek.

STATEMENT OF S. S. PECK, OF HAMLIN COUNTY.

Mr. Chairman and gentlemen: Our county is just where the headwaters of the Sioux River are. The county of Coddington contains the large Lake Kampeska. Of that I can not say much. I have been there, and I think it is practical to make a very extensive reservoir at Lake Kampeska, and a large supply of water can be held there. But in the spring, when we have rain, down comes the water, and in a couple of weeks it is all gone, and the balance of the season we are without water. Even the Sioux River dries. But sometimes it will be 10 or 15 feet deep. The fact is there is nothing to stop it. We have too little when we want it, and too much when we do not need it.

One-twelfth of Hamlin County is water. We have not suffered from drought until this year. We feel that the reason is that we have not the effect of those large bodies of water. But there is a difficulty to contend with. There is a large amount of water in the spring, and it keeps evaporating and leaves a large portion of the surface in such a condition that it becomes unhealthy. If those lakes were dammed, it would answer the purpose of keeping a quantity of water there. These lakes lead into the Sioux River in the end; but a number of the creeks would furnish us water for our stock.

We have three streams, not as large as the river, running through that county, which are susceptible of having large reservoirs made upon them. The water being so regulated, we could have water furnished the whole summer through. It could be all retained in these reservoirs and let off as wanted.

The CHAIRMAN. What is the area occupied by the different lakes that supply the Sioux River?

Mr. PECK. One-twelfth of our county. It is composed of eighteen townships, and over one-twelfth of our county could have water. This year we have not suffered from drought to the extent that I find in most every other place; and yet, if reservoirs were built we could have the use of that water. We have not suffered to any great extent for water there.

The CHAIRMAN. Is that true all the way down the river? Would it not be an advantage to take it out and spread it upon the land below?

Mr. PECK. Most undoubtedly, and upon our land. If the water could be retained in Kampeska—that which runs away past us in the Sioux River—it would irrigate our land down, 10 miles on each side of the Sioux River, for 20 or 30 miles. I have not seen the river, and I do not know anything about it.

The CHAIRMAN. Is it not possible that you would have reservoir surface enough if these lakes were so dammed that you could handle the water in them? If you could store it in reservoirs, would you not have water enough from the Sioux River on both sides?

Mr. PECK. Yes. I have had some little trouble with those reservoirs in the country I came from. We had reservoirs at one time, but the streams were all blocked and the water got off so slowly that it kept our rivers up all through the season. There was no want of water then. After we cleaned up the creeks all the water ran off in a few weeks, and we had to build dams. But now we have it in perfect control. Now the river is in good condition. I know how that was; I have seen it. But locally we can not furnish the money.

Senator REAGAN. There has been no effort by private or corporate enterprises to do anything for themselves?

Mr. PECK. No. There is not sufficient capital there. It could not be managed by private capital. Some who were to be benefited by it would stand off, and that would prevent all of us—they would just stand still, and that would balk the whole thing. That is the way we feel. If we could have those lakes dammed we could have plenty of water to irrigate our land. There was a remark made by one of the gentlemen to the effect that if he could wet his land and thoroughly soak it in the fall he could raise a crop. I fully appreciate that.

The CHAIRMAN. Some of the gentlemen who gave us information at St. Paul said that in some of the localities where they resided they had rich alluvial surface, and 2 or feet underneath a bed of clay that preserved the water. Does that pertain to this country here?

Mr. PECK. I will tell you what I have seen in connection with my own farm. I have a large bed of clay, and I retain every drop of water that I get—the clay holds the water. You can dig down here in most places that I have seen, get into the clay and fill it with water, and it will evaporate—not run away.

The CHAIRMAN. That is a most favorable circumstance. By means of it a ditch along the side of the hill will irrigate a farm without spreading the water over it. Your irrigation is going to be a very easy matter. If you have a ditch running above your land where you have a clay foundation you can irrigate the land very cheaply, if you have rolling land.

Mr. PECK. That is the kind of land we have.

STATEMENT OF DAVID HALL, OF ONEIDA, SULLY COUNTY.

The CHAIRMAN. What has been the condition of things in your county?

Mr. HALL. Well, as a general thing, it has been very dry there. In our county we have never succeeded in raising a good crop of grain, on account of the drouth in June.

The CHAIRMAN. Have you tried irrigation?

Mr. HALL. No.

The CHAIRMAN. What means have you for irrigation ?

Mr. HALL. None, only from the Missouri River, and, of course, that would be very expensive and could only be done by large capital.

The CHAIRMAN. The Missouri is down deep.

Mr. HALL. There are bluffs.

The CHAIRMAN. Above the water what is the average height of those bluffs ?

Mr. HALL. I should judge about 100 feet.

The CHAIRMAN. I mean to get back to where you would have the range of level land.

Mr. HALL. From the river to level land back it is about a mile and a half or two miles.

The CHAIRMAN. That would be an elevation of how much ?

Mr. HALL. Not more than 50 feet above the Missouri. I do not know ; I am making a guess at it.

The CHAIRMAN. The bluffs are higher than the land back of them ?

Mr. HALL. Yes.

The CHAIRMAN. Is there a large area of land back there ?

Mr. HALL. Yes.

The CHAIRMAN. Extending how many miles across ?

Mr. HALL. Almost across to the James River. Between the James River and Missouri River there is an elevation ; but it is not hilly as a general thing ; it is mostly level land.

The CHAIRMAN. If the river could be taken out and run in a canal on that ridge between the two, it would serve to irrigate both sides, would it not ?

Mr. HALL. Yes, I think it would.

The CHAIRMAN. You say you do not raise crops there when it is dry ?

Mr. HALL. Not sure crops. But I have not had an entire failure. Our average in that county, of wheat, has not been more than 9 or 10 bushels, I should judge, to the acre.

The CHAIRMAN. Are you able to raise vegetables—all-round crops ?

Mr. HALL. Yes ; and corn. I have good success with corn, because we always have a wet harvest. This is my seventh year there.

The CHAIRMAN. It rains in July and August ?

Mr. HALL. In July and August we always have it wet. In June and fore part of July we need the rain most for the grain, and we do not have it.

The CHAIRMAN. You have no streams except the Missouri that could be utilized ?

Mr. HALL. No.

The CHAIRMAN. There are none between here and Bismarck going into the Missouri that could be utilized ?

Mr. HALL. I could not say. I was never through there.

Senator REAGAN. Is the Missouri navigable where you speak of ?

Mr. HALL. Yes.

The CHAIRMAN. It is a thousand miles above here ?

Mr. HALL. About 1,250 miles.

STATEMENT OF I. R. SPOONER, OF KINGSBURY COUNTY.

Mr. Chairman and Gentlemen: My county is in the eastern part of Dakota. Lake Preston is the post-office. It is 75 miles northwest of this point on the headwaters of the Vermillion River. A portion of the eastern part of our county is covered by the lakes which are practically the headwaters of the Vermillion. The outlets are now drying.

The CHAIRMAN. Is there any water in the lakes now ?

Mr. SPOONER. Yes. There is water in Lake Thompson, which is 65 miles long and about a mile and a half in width. Lake Henry is $2\frac{1}{2}$ miles in diameter. Preston Lake is 2 miles long. Lake Whitewood is 10 miles long and $2\frac{1}{2}$ miles in width.

The CHAIRMAN. What would be the cost of getting water out from there ?

Mr. SPOONER. At present it would require considerable cutting, but the facilities for storing water are good. In 1881 the outlet of Lake Henry flowing into Lake Thompson and from there down into the channel, which leads into the Vermillion, was full of water, and also in 1882 for nearly half a season.

The CHAIRMAN. There was water enough fell to raise it a good deal higher had there been a dam to save it ?

Mr. SPOONER. For instance, Lake Henry, $2\frac{1}{2}$ miles in diameter, would have covered a third more area and would have risen 5 or 6 feet. Lake Thompson would have covered probably an area one-fourth more and would have risen 2 or 3 feet. That is a rough estimate.

The CHAIRMAN. Do you usually have a series of dry seasons ? If you had only one dry season you might store the water and save it for a season or two and keep filling the lakes, and then, when the dry season comes, be prepared for it.

Mr. SPOONER. One season our lakes were dry with the exception of Lake Henry and Lake Thompson. The others were full. That was in 1880 and 1881, from the deep snow. The snow blew in and filled them. They were not filled by rain-fall ; but the rain-fall replaced the evaporation and kept them up until the dry season, which occurred four years ago in our part. Our county is on this side. The east part is covered by these lakes. This season the eastern part of our county has 40 per cent. of wheat crop, probably 50 per cent. ; 80 per cent. of corn crop ; and 30 of oat crop. The western part has no crop at all, none probably worth mentioning. The slough, which we call the Vermilion, and one lake in the northern part of the county—Spirit Lake—are in the dividing part of the county, twenty-four townships north and twenty-six townships east—it is impossible to make an exact division.

The CHAIRMAN. Have you this same substrata of clay ?

Mr. SPOONER. Yes, the characteristics of the soil are the same. Wherever you dig down you come to clay.

STATEMENT OF H. W. EDDY, OF CANOVA, MINER COUNTY.

Mr. Chairman and gentlemen: I am going to speak of the driest place on earth—Miner County, Sanborn County, Hand County, and McCook County, which are very much alike.

The CHAIRMAN. In what part of the Territory is your county ?

Mr. EDDY. Fifty miles north of here. You will go through it when you go north.

The CHAIRMAN. As we go to Huron and Jamestown ?

Mr. EDDY. It reaches clear through to Huron, and it is all very much the same kind of country. We have no lakes at all ; but there are lake-beds. They appear to be everlasting lakes in the wet part of the year ; but they dry up.

The CHAIRMAN. Have you any stream ?

Mr. EDDY. There is one on the western border and one west of that. The water runs continually in them. But last year there was no water in them three months in the year.

The CHAIRMAN. If you had reservoirs at the head could not a ditch be brought around to supply you with water?

Mr. EDDY. If there were water we could get the ditch.

The CHAIRMAN. The topography of that country is all alike?

Mr. EDDY. Yes; if you go on a level you will not see a hollow until you get onto it. It is a level county, not flat but level, and you can see the little towns 10 or 15 miles distant. We have been dry four years; but this is the driest season of them all. We have in Miner 15 per cent. of wheat perfected this year. No wheat is better, and our corn crop is only about 50 per cent.

The CHAIRMAN. Have you thought of any method of getting moisture?

Mr. EDDY. No.

The CHAIRMAN. Have you tried artesian wells?

Mr. EDDY. We have artesian wells in the western part of Miner County. You put a 2-inch auger down 25 or 30 feet and the water gushes up through a gas pipe. The farmer has plenty of water for his stock, etc., but not sufficient for irrigating purposes. It would take many of those small wells for that purpose. What large wells would do we have never tried. There are in Miner County, the western part, some three hundred of those wells, and Sandborn is still better off with them.

The CHAIRMAN. You say there have been no experiments tried with large wells in that section?

Mr. EDDY. No; there is one at Huron, but I think there are none south of that until you get to Plankinton. Mitchell, farther south, has one.

The CHAIRMAN. Are you on the James River?

Mr. EDDY. No; we are 3 miles east of it.

The CHAIRMAN. Are you familiar with that river?

Mr. EDDY. I have seen it frequently, the lower part of it.

The CHAIRMAN. You have followed it up?

Mr. EDDY. No; I have not noticed it since I lived in the country, since 1882. The first three years we had an abundance of rain, and after that the showers would rise in the northwest. They would make a little spot no larger than a man's hat, and then they would slip by, and go by the lakes and by the James River and leave us out in the cold. Whether there is anything in the power of the lakes and the river to draw these clouds I do not know; but they go there and leave us. You have asked a number of times whether we have tried irrigation. I never saw soil that would jump so when it had a little moisture. I raise plenty of potatoes and garden stuff, and when we have moisture we have an Eden.

STATEMENT OF HENRY NEILL, OF MILLBANK, GRANT COUNTY.

Mr. Chairman and gentlemen: Our county is 125 to 150 miles north of here. We are located on the coteaux, or hills, and have a slight incline toward the Big Stone Lake. Those ridges are nearly a thousand feet high. They have innumerable streams that verge toward, and quite a number of streams that run into, the James and Missouri Rivers. In the northern part of our county we have gone down 300 feet and struck granite—failed to get artesian wells. But in the center of that county we have artesian wells. There a farmer will bore 8 or 10 feet with an augur and get a well, and the water from it will rise above the surface. But those wells are not strong; they are not used for irrigation purposes.

But I think the problem of irrigation would be very greatly aided by a series of artificial dams on the streams in our county. We are usually troubled with a very dry season in May and June, which is the time for crops. The balance of the year we could get along very well. All those streams are supplied by the snow that melts in spring, and if the water could be retained in them irrigation would be materially aided. The problem with us is to retain the overflow. We have propositions before the Government with regard to damming Big Stone Lake, and there have been some reports made on the subject. But the Government will not take the question of irrigation into account; it is simply concerned about navigation. But I trust this committee will take into consideration the question of damming our lakes and rivers.

STATEMENT OF H. A. HUMPHREY, OF FAULKTON, FAULK COUNTY.

Mr. Chairman and gentlemen: Faulk County is on the north line of the two States of Dakota, and the whole county lies within the area or scope of the James River Valley—the west valley, near the divide between the James and the Missouri Rivers. The lakes that we have are drained in twenty-four hours. But there are some streams that could be utilized; they, however, are comparatively few within the area where we could derive any benefit from them.

I was born in northern Illinois, and have lived in Iowa; they are the richest agricultural districts in the United States. But I never saw a soil that will produce equal to the Dakota soil if it has water. When we have water we have the crops, but in late years we have not had the water; there is no water above ground, and the only way for us to do is to get it from below. When I came here there were lakes and streams all over the country, and there were dews every summer, and every blade of grass was loaded with moisture; up to 10 o'clock or 11 o'clock in the day it was like wading in water; but that is not the case now.

The CHAIRMAN. You have in your section the same clay substrata that there is in other parts of the Territory.

Mr. HUMPHREY. Yes; we call it clay, but I doubt very much whether it is clay after all. It is clay until you get down to the blue clay. The subsoil is somewhat of the nature of a soil that is filled with what people call marl; but that does not get any moisture all the way down.

The CHAIRMAN. It holds moisture?

Mr. HUMPHREY. Yes; but the moisture disappears; we have none on the top of the ground. If we had reservoirs we would have rain and dews from evaporation.

STATEMENT OF WILLIAM STODDARD, OF BROWN COUNTY.

Mr. Chairman and gentlemen: The famous James River runs through the center of our county, but we can not get water enough from that to do us any good. I have thought that four or five artesian wells at any place in the James River Valley would supply as much water in the summer time as the James River. My remarks would be similar to those of Mr. Humphrey in regard to artesian wells. That is the system we shall have to enter upon if upon any system of irrigation; because we can get artesian wells at almost any place in this valley, which is 250 miles long and 50 miles wide.

There has not been one season since the settlement of Dakota when moisture was not needed. In our county we have had very few that

you might call failures; but, as I say, there has been no season when we did not need moisture. The last two or three seasons we have had failures—one-third of a crop—while if we had a system of irrigation we could have had our usual crop of 20 bushels to the acre. We have to go from 800 feet to 1,000 feet to get water, and then we can get a stream of water almost any size. Six inches is the largest we have in the county or that portion of the State. I have forgotten how many barrels that will flow an hour. But at Groton they have a ditch 5 feet wide and 2 feet deep—a pretty fair stream. If we had the capital to go on and sink artesian wells we have no doubt they would prove successful.

This is the first season that there has been much talk on the subject of artesian wells, simply, I suppose, because this is our first failure. But there would be no difficulty, in my opinion, in getting artesian wells. I have my views about irrigation. Near the city of Aberdeen, at which place you have been invited to stop, some water was accidentally left in a ditch last fall. We have had no rains since harvest last year, and very little this summer. Right near this ditch an acre of land is good for 40 to 50 bushels, but beyond that the balance of the field seems to be a failure. I speak of this to show what irrigation will do for us.

STATEMENT OF H. HOLE, OF HURON, BEADLE COUNTY.

Mr. Chairman and gentlemen: I have a somewhat different idea of this irrigation question from those expressed here this morning. I have gone to the trouble to examine the irrigation question in Colorado, Wyoming, Utah, Idaho, and Montana. I find there it costs \$20 an acre to irrigate, for the reason that they have to dam their streams and bring the water for miles—a great many miles—at great expense. When we found artesian wells possible in our valley, it struck me that we had right at our doors what the people of those States and Territories had to bring from great distances. My idea is that an artesian well on every section will irrigate that section of land; and to construct the well it will cost \$2,500. The flow from a well of that kind will cover 640 acres of land 2 inches deep every 24 hours. Estimates have been made by parties who are experts, and they say that there is no question that a well costing \$2,500 would irrigate one section of land; and the plan would be to irrigate with the same care and the same survey and ditches that they have used in Colorado and Utah and the other irrigating States. They would in that way, and at a cost not to exceed \$6 or \$7 an acre, irrigate the land, while in the other States and Territories it costs about \$20 an acre. If this land were irrigated in that way, it would add much to its value, equal to that in the other States and Territories—\$20 an acre. Yes; I believe in the James River Valley, within the artesian basin, the lands can be, by a system of irrigation such as I suggest, increased in value \$20 an acre. In this Territory the question of dams will be eliminated when you come to get at the fall of the river. There is no fall in these rivers that will ever furnish water by the dam-reservoir system. And even if the water could be furnished, it would be no better water and would cost a good deal more. On every farm we have the water, and all you have to do is to bore a hole and let it come up.

And you can irrigate by the natural gravity of water. The pressure of these artesian wells is about 170 pounds to the square inch—some of them going as high as 200 pounds. The rain-fall here is about as mentioned—22 to 28 inches. That ordinarily would be enough to make a crop, but the winds dry up the water and the evaporation is very rapid.

But give us ten days' irrigation, and we can assure 40 bushels of wheat to the acre. Now, every year we expect crops and have the best prospects for them, but the dry winds come and dry up the soil. I think that the artesian will be the cheapest water-power that can be had in the world, as you will see when you examine the artesian wells at Huron, Aberdeen, and Redfield. There they use the artesian power to run the machinery about the city.

Senator REAGAN. What is the size of the well at Huron?

Mr. HOLE. It is a 6-inch well, with a pressure of 175 pounds to the square inch.

Senator REAGAN. Do you know how deep that well is?

Mr. HOLE. Nine hundred and some feet. That well cost in the neighborhood of \$4,000; that was just one well—an experimental well. We have an offer to put down an 8-inch well for \$2,500 within a few miles of our town.

STATEMENT OF C. L. WOOD, OF RAPID CITY, PENNINGTON COUNTY.

Mr. Chairman and gentlemen: Pennington is one of the counties of the Black Hills—a southwest county. Other southwest counties are Fall River County—that is the southwest corner county of North Dakota; and then, passing along the Wyoming border, comes Custer County, Butte County, Meade County, which is east of Lawrence—six in number. They represent the organized country in South Dakota west of the Missouri River. This country is all surrounded by the two forks of the Belle Fourche and the South Cheyenne, coming together about 40 miles north from Rapid City. The east half of that Territory is agricultural country, and the west half is in the mountains and is a mining country. We have a number of streams that put out from the mountains, and each stream runs straight through to the Cheyenne River. The streams in their order are the Redwater, Spearfish, Whitewood, Elk Creek, Box-elder, Rapid Spring Creek, Battle Creek, and French Creek. These creeks are practically parallel, and on an average of about eight miles apart. They are practically of the same width. For instance, a small portion of Rapid Valley is under irrigation. The valley of the Spearfish is also under irrigation. But the streams having their source in the mountains are dry on the plains, with the exception of the Spearfish, and, of course, can not afford to supply water for irrigation purposes.

The CHAIRMAN. Are there any facilities for storing water in that vicinity?

Mr. WOOD. There are good facilities for storing water. All those lakes burst out of a gap. The gap is always in the outside range. Inside the outside range there are generally large basins, which could be used for the storage of water. I think each stream is supplied with two basins which could be used as reservoirs. By damming across the gaps you could form large reservoirs at the back.

The CHAIRMAN. There is a good deal of water in those streams which in the spring runs to waste?

Mr. WOOD. Large volumes pass out during the spring, with the exception of the Rapid and Spearfish.

The CHAIRMAN. What is the effect of irrigation there?

Mr. WOOD. Since my residence in that county, twelve years, we have had three summers of extreme drought; but in those valleys where irrigation is possible and is pursued the crops were as good during this

dry season as at any other time. There the soil is productive, and the wheat crop averaged 60 to 70 bushels to the acre. I have seen 60 to 70 bushels taken off an irrigated field, while there was a complete failure above the ditch, although there is no difference in the character of the soil. Then, this year where we have had plenty of rain and the irrigation ditches have not been used there is no difference in the crops. So that proves that there is no difference in the productiveness of the soil.

The CHAIRMAN. What is the distance that can be irrigated by these streams?

Mr. WOOD. Sixty miles north and south and 40 miles west. It can all be irrigated. These rivers come together on the east side, and the divides are capable of being supplied with canals, so that all of them could be utilized.

The CHAIRMAN. You think there are storage basins where the water could be held back?

Mr. WOOD. I think that such is the case.

The CHAIRMAN. Have you in your section this subsoil of marl or clay that has been described here?

Mr. WOOD. It is in the divides, but the valleys seem to have cut through that or depressed it. In the valley the immediate subsoil at an average of 10 feet would be gravel, but on the divide there would be no gravel but a stratum of clay 6 feet in depth. But the streams that do not run dry, the Rapid and Spearfish, have not a sufficient volume of water to irrigate more than the land included in their valleys; they could not furnish enough to go over the divides.

The CHAIRMAN. Does not a large percentage of that water run out in flood time?

Mr. WOOD. Yes; a great volume comes down; but they are considerable streams at all times, though the volume is not more than enough to furnish the valleys through which they pass.

Senator REAGAN. State what is the average price of farming land in that country.

Mr. WOOD. Unimproved land is from \$8 to \$10 an acre; some lands are higher than that, but that would be about the average.

Mr. E. J. HINTON (Irrigation Engineer, U. S. Geological Survey, with the committee as expert). What would be the value of Government land as compared with that?

Mr. WOOD. I think the Government land would not be far from the value I have named.

STATEMENT OF C. H. VAN TASSEL, OF SANBORN COUNTY.

Mr. Chairman and gentlemen: I am from the southern part of the Territory. I have not noticed that any of these gentlemen have stated that the crops have been affected by the flow from these artesian wells.

In my county they get these shallow wells from 75 to 115 feet. I noticed a few days since where one of these wells, which flows through a 2-inch gas-pipe into a ditch and then onto a lake-bed a half mile away, that on each side of that ditch for about 30 or 40 rods back the crops of both wheat and oats were good, and that on the same field, farther away, there was no crop at all; it was all burned out.

In the western part of the county, in the village of Letcher, there is a deeper well. That well has a depth of 600 feet, and it was obtained at a cost of \$2,200. It is now about six or seven months since that well

was sunk, and it has created a lake there in a natural lake-bed or depression covering perhaps 100 acres, and then there is an outflow which extends for about 7 or 8 miles to the James River. I noticed this season that in the vicinity of that lake, that depression, where the outflow is clear to the James River, they will cut grass from $1\frac{1}{2}$ tons to 2 tons per acre on each side of the stream, while 80 rods away the prairie would have burned out at any time within the last three or four weeks. I am acquainted with much of the country known as the James River Valley, and while it is a level prairie there are in it numerous lake-beds or depressions covering from 40 acres to a section, any of which could be filled by an artesian well. They have hard-clay bottoms, and from them the water could be carried off by irrigation ditches.

The CHAIRMAN. Have you ever seen an artificial ditch running along the side of a hill, and can you say how that would affect the land below?

Mr. VAN TASSEL. I have not in this country. The water will percolate through the soil to the clay subsoil that is below, but it does not percolate through that at all.

The CHAIRMAN. Have you noticed the effect of this percolation through the soil from a ditch along the hill-side?

Mr. VAN TASSEL. In this natural ditch of which I spoke, from the well in Letcher Township, the effect is shown in the grass. I have not noticed the effect where the ditch is near any cultivated crop. But in that one place I noticed that it affected the grass for nearly half a mile. I noticed it in the city of Yankton. There they have two artesian wells, and the waste water from the city well affects vegetation for 40 or 50 rods from the waste ditch. There would be no trouble at all any place through what is known as the James River Valley country in obtaining reservoirs, because there are natural sites in the shape of those depressions and lake-beds. They will hold the water without any trouble.

The CHAIRMAN. You have been a surveyor all through this country. Suppose you had the water of the Missouri out on the table-land a few miles back from the river at any point above here, would there be any difficulty in the way of running it down by means of a canal?

Mr. VAN TASSEL. No; the natural lay of the country would be suitable.

The CHAIRMAN. How far up?

Mr. VAN TASSEL. To the head of navigation—Fort Benton.

The CHAIRMAN. Are there any opportunities for taking out the Missouri River?

Mr. VAN TASSEL. I believe there is no feasible way.

The CHAIRMAN. Have you ever looked at it with that view?

Mr. VAN TASSEL. No; not with that view.

The CHAIRMAN. How far out on the Missouri would you have to go before you would have rock bottom?

Mr. VAN TASSEL. There is rock bottom in numerous places, but not very extensive. For instance, there is a chalk-rock bottom a few miles above Yankton, but it extends only a few miles. There is no place that I now remember where the rock bottom is very extensive for any distance up and down the stream.

The CHAIRMAN. Is there any place where there is a firm reef and where you could take the water out?

Mr. VAN TASSEL. Not to any extent.

The CHAIRMAN. Have you noticed any place where there is a reef of rocks, a dike, where you could start from without any great expense?

Mr. VAN TASSEL. There is none this side of Fort Buford.

The CHAIRMAN. How far would that be by the line of the county?

Mr. VAN TASSEL. In the neighborhood of 700 miles.

The CHAIRMAN. 700 miles by land?

Mr. VAN TASSEL. Yes.

The CHAIRMAN. Would it go all the way through good country were it taken out?

Mr. VAN TASSEL. Yes; nearly all the way.

STATEMENT OF V. T. MCGILLICUDDY, OF RAPID CITY, PENNINGTON COUNTY.

Mr. Chairman and gentlemen: I would like to make a few remarks with regard to the Black Hills country and a part of the Sioux Reservation that is to be opened up to settlement.

I suppose you gentlemen are aware of the fact that the only moisture which we get in this region is from the Gulf of Mexico and the region of the Great Lakes. We get none from the Pacific Ocean, for the reason that the Rocky Mountains reach above the cloud line in altitude, thus cutting off moisture from the Pacific Ocean. Every mile that you go out of the Black Hills the more the rain-fall diminishes, and so the people have to depend on irrigation. This portion of the Sioux Reservation which will be opened up to settlement, 16,000 miles in extent, is remote from the Black Hills moisture. The land there is very fertile generally, but I apprehend the difficulty will be the want of rain-fall, except near the Missouri. The nearer you get to the Missouri the more rain-fall there is. Like the Black Hills, the river increases rain-fall and dews. But the only future I can see for anything like reliable crops on that reservation will be from irrigation by means of artesian wells.

The CHAIRMAN. No experiments have been made there for the purpose of ascertaining whether there is an artesian belt?

Mr. MCGILLICUDDY. It is an Indian reservation. Part of it is called the Bad Lands; no agriculture is possible on them. At the same time there are valleys that will prove fertile if we can get water on them.

The CHAIRMAN. Are there no streams running through the Bad Lands?

Mr. MCGILLICUDDY. There is very little water on the Sioux Reservation. There is a strip of country, 5,000 square miles in extent, running through to the Missouri, that will be opened up to settlement. There the altitude is higher than it is here.

The CHAIRMAN. Is there any vegetation there?

Mr. MCGILLICUDDY. There is vegetation—buffalo grass. The grass is rich, and 4 or 5 feet in depth.

The CHAIRMAN. Is there much timber?

Mr. MCGILLICUDDY. Very little, except along the lakes.

The CHAIRMAN. You have been living in the Black Hills country. What has been the effect of cutting timber off the banks of the streams?

Mr. MCGILLICUDDY. I think it reduces the amount of water in the streams.

The CHAIRMAN. How are they doing in that country; are they saving the undergrowth, the brush?

Mr. MCGILLICUDDY. The mining companies have been cutting off the timber for mining purposes, and they have not spared it. The law requires that nothing under 8 inches shall be cut. The mining companies do not respect the law, and they do not clean up the small brush. It catches fire, and in the fall that causes the undergrowth to burn.

The CHAIRMAN. Have you thought of a way of remedying that—I mean by legislation?

Mr. MCGILLICUDDY. We have laws enough if they were carried out; but the laws have not been carried out.

The CHAIRMAN. If instead of secret agents suppose men from these timber districts were appointed—not to sell the land, but to regulate the cutting of timber—could anything be accomplished?

Mr. MCGILLICUDDY. These timber agents sent out by the Government are spies. They make secret reports, but the local land officers can take no cognizance of these things.

The CHAIRMAN. Do you not think it would be better to have the local land offices responsible?

Mr. MCGILLICUDDY. Yes; if the people living there were responsible it would be better. There is a great amount of timber cut off the Black Hills.

The CHAIRMAN. Timber that is necessary for agricultural purposes? What I have reference to is regulating the cutting of timber so as to preserve the undergrowth, and to have the dead timber taken away to prevent fires. That is not done now.

Mr. MCGILLICUDDY. No, you will find large regions of timber where fires have been. These have gotten into the growing timber. Sometimes it is set afire by lightning and sometimes by carelessness. In the dry season, when there is a drought, the farms on the upper benches have turned out better than in the valleys, and as an explanation of this we find that in sinking a well at 10, 15, or 20 feet you strike water. That water remains the year round, which proves that when you get upon these benches there is an impervious strata 10 or 15 feet below the surface, and above that a gravel loam. If that water remains the year round it must be held by a basin, and this water at that depth keeps rising up through the dry season. But when you get over the rim, down into the valleys, the water is not held, but slides under the creek beds and flows out of the country. So that those bench-lands are being taken up. But I apprehend that the settlers who in the first place come into the Sioux Reservation will have to suffer. There are some 11,000,000 acres to be taken up.

The CHAIRMAN. There ought to be accurate information furnished before they go there. It is pretty costly going there to fight this case.

Mr. MCGILLICUDDY. I particularly urge that something be done in the way of artesian wells in that portion of the reservation, because the first comers can not sink wells 200 feet to try the experiment.

A copy of the following memorial was presented on behalf of the State constitutional convention:

To the Congress of the United States:

The constitutional convention of the State of South Dakota, duly assembled, would respectfully represent to your honorable body that it has been demonstrated that within the limits of South Dakota there exists what is known as an artesian basin or system, but that its extent has not been fully determined, and that a desire is being generally expressed by the people of South Dakota that the matter be investigated and the extent of the system fully determined, and its availability for the purposes of agriculture and manufactures be determined.

Now, therefore, the said convention would respectfully memorialize your honorable body and request you to appoint at the earliest time a commission for the purpose of making and with power to make a thorough and complete geological and hydrographic survey of this State, including the mineralogical formation of the Black Hills and the artesian basin of South Dakota, and that you make the necessary appropriations therefor.

[Signed by the officers of the constitutional convention.]

SIoux FALLS, S. DAK., *August 2, 1889.*

The committee met at 7 p. m.

Present: Messrs. Stewart (chairman) and Reagan, also Director Powell.

STATEMENT OF W. F. SMITH, OF MADISON, LAKE COUNTY.

The CHAIRMAN. Do you need irrigation in your county, and if so, how do you think it can be obtained?

Mr. SMITH. We do need irrigation. It can only be obtained from artesian wells.

The CHAIRMAN. Have the crops suffered in your county for want of water?

Mr. SMITH. They have suffered somewhat. However, we have a fair crop in our county.

The CHAIRMAN. Is there any stream running through your county?

Mr. SMITH. No.

The CHAIRMAN. How are you situated with reference to the James River?

Mr. SMITH. We are 50 miles east of the James River and 24 miles west of the Sioux River.

The CHAIRMAN. Have you tried the experiment of artesian wells?

Mr. SMITH. No, sir; we have never tried them.

The CHAIRMAN. So you do not know whether you have water there or not?

Mr. SMITH. We do not know whether we have water underneath us or not.

The CHAIRMAN. Where are the nearest wells?

Mr. SMITH. Twenty-five miles west of us. They are not very deep wells, however.

The CHAIRMAN. You are east of the ridge?

Mr. SMITH. We are east of the center.

The CHAIRMAN. At about what elevation in that neighborhood is the center above the two rivers?

Mr. SMITH. I do not know that I can answer that question. I would not undertake to guess at it.

Mr. HOWE. It is not very high—perhaps about 50 feet.

STATEMENT OF H. J. PATTERSON, OF MADISON, LAKE COUNTY.

The CHAIRMAN. What is your occupation?

Mr. PATTERSON. I am in mercantile business at Madison.

The CHAIRMAN. Is it a fact that you need irrigation in your county?

Mr. PATTERSON. We have a considerable amount of land in our county that is affected more or less every year by the drought. The county has been affected by it this year. It has always seemed to me that it would be an advantage to us if we could have irrigation.

The CHAIRMAN. Have you ever had any examples of the results of irrigation in your county?

Mr. PATTERSON. No, sir; only as we might see it along the line of the little brooks throughout the county. It can be seen that the grain and grass are more thrifty in those locations.

The CHAIRMAN. There are no ditches, are there, turning the water onto the land?

Mr. PATTERSON. None whatever.

The CHAIRMAN. What is the character of the soil in your locality?

Mr. PATTERSON. It is a black loam.

The CHAIRMAN. What underlies the soil?

Mr. PATTERSON. Gravel; when we get down 3 or 4 feet we find a gravel bed for the most part. Sometimes we strike blue clay.

The CHAIRMAN. No wells have been dug in your part of the county?

Mr. PATTERSON. No wells have ever been dug in our county. These gentlemen here have done more than anybody else in order to see if they could get a well, but they did not succeed in getting one.

The CHAIRMAN. How deep did they go?

Mr. PATTERSON. About 300 feet deep, I think, or perhaps 330 feet. I think there is water there if we could get at it.

The CHAIRMAN. What makes you think there is water there?

Mr. PATTERSON. Because west of north from us they have artesian wells which they dug at 100 feet, more or less. The surface of the land seems to be about the same all the way through.

The CHAIRMAN. Is there any appearance about your locality of this quartzite that you have here?

Mr. PATTERSON. No, sir; there is none of that in our county.

The CHAIRMAN. There are no streams, you say, from which the water could possibly be obtained?

Mr. PATTERSON. There are none in our county.

The CHAIRMAN. Are there any streams running along there that could be diverted into your county?

Mr. PATTERSON. I do not think so, unless they could divert the James River.

The CHAIRMAN. But there is not water enough in that for every purpose, is there?

Mr. PATTERSON. No; nothing that would materially help in a dry season.

STATEMENT OF S. W. JACOBS, LAKE COUNTY.

The CHAIRMAN. How far from Madison do you reside?

Mr. JACOBS. About 3 miles south of Madison, Lake County.

The CHAIRMAN. Tell the committee what you know regarding the needs of your county in the matter of irrigation, and how you think irrigation can be obtained.

Mr. JACOBS. The knowledge that I have has been gotten from other parties. Parties that have bored more artesian wells than any others in Dakota say that we should be able to get water there, according to the stratification of the earth. There is water to the north and west of us, and also to the south of us, underground. We are in the line of the granite formation. In Salem, water has been found just on the top of the rock. They cut through the rock at another place and struck water—very fine water.

The CHAIRMAN. How deep did they go?

Mr. JACOBS. The first trial was about 600 feet, and I believe the last trial was 800 feet or 900 feet.

The CHAIRMAN. That is, they cut through this quartzite?

Mr. JACOBS. Yes.

The CHAIRMAN. How much water did they get when they cut through that?

Mr. JACOBS. They got a good well. They did not get a flowing well at either Salem or the other place, but they got an ample supply of water.

The CHAIRMAN. It was a pumping well, was it?

Mr. JACOBS. Yes.

The CHAIRMAN. A pumping well will not do much towards irrigation, will it?

Mr. JACOBS. No; but if they got good water at that depth, they should get a flowing well by going deeper.

The CHAIRMAN. But they do not always get that?

Mr. JACOBS. Not always; but there is 30 feet of water in the lake.

The CHAIRMAN. Why do you allow 30 feet of water to remain in the lake if you want water for irrigation around the country there?

Mr. JACOBS. Because it costs too much to get it out. The banks of the lake are 25 feet high.

The CHAIRMAN. Is that the full height?

Mr. JACOBS. That is about the height. Madison is about 3 miles northwest of us, and there is a range of hills between Madison and the ridge.

The CHAIRMAN. How does it discharge when it is full?

Mr. JACOBS. It runs through the Skunk River, and from that into the Sioux, and past Sioux Falls. Lake Hermann is west of Madison. It is a small lake and is a trifle higher than Madison, but not very much.

The CHAIRMAN. It seems to me that would be a very good reservoir if you could dam the water up.

Mr. JACOBS. You would have to elevate it in some shape to get it into the surrounding country.

The CHAIRMAN. It will not run either way?

Mr. JACOBS. It would run from this little creek that we call the Skunk River. It has to run through another lake before it comes to that.

The CHAIRMAN. Is there not some country to be irrigated before this chain of lakes is reached?

Mr. JACOBS. There are hills on both sides.

The CHAIRMAN. All the way?

Mr. JACOBS. All the way.

The CHAIRMAN. And it comes into the Sioux River?

Mr. JACOBS. Yes. Wherever the land has retained the water the crops have been good, but when the water could not reach it of course they have been poor.

The CHAIRMAN. The lake is not high enough to get water from it to your land at all?

Mr. JACOBS. No; and during this time of the year there is no outlet to it. In the early part of the year, when the water is high, there is an outlet.

The CHAIRMAN. How far from you did they bore a well and strike this quartzite?

Mr. JACOBS. At Brookings, which is about 25 miles straight north from here.

The CHAIRMAN. Then your place is between that point and this?

Mr. JACOBS. Yes, just about, but a trifle west.

Mr. HINTON. Has anybody ever suggested, in your region, that that chain of lakes could be made useful for general irrigation purposes? The lakes run above you a considerable distance all through those counties, do they not?

Mr. JACOBS. But the range of hills on each side of them would be so high that without an immense amount of water dammed up you could not use it. You would have to force the water up. If you could get the water beyond the range of hills adjoining the lake on each side, it could be used to advantage.

STATEMENT OF F. G. YOUNG, OF MADISON, LAKE COUNTY.

The CHAIRMAN. Have you given any thought to the question of getting more moisture in your region?

Mr. YOUNG. Although our crops have not been complete failures for the last three or four years, still I know they would have been greatly benefited by an increased amount of moisture. The only feasible, or even possible, way that we could get water for irrigation would be by means of artesian wells. I am not sure whether there is a possibility of that. One point that would incline me to believe that there is, is the nature of the subsoil. Although it has been stated here that it is a gravelly subsoil, I know there is a great deal of difference as to its imperviousness to water and the clay subsoil of Wisconsin. The depressions here keep their water through long-protracted seasons of drouth; they would not retain it in Wisconsin, with yellow clay subsoil; that is, the clay that has not a very deep subsoil here has running through it a shallower stratum of a very compact marl, and that is quite impervious to water.

The CHAIRMAN. That holds the water?

Mr. YOUNG. That holds the water well.

Senator REAGAN. How far is that from the surface?

Mr. YOUNG. I should say 3 or 4 feet. I have dug post-holes and dug a well there where they found this marl, and it was in the upland too; so that it is not confined to the depressions alone, although I suppose there are some knolls or hills where it would not be found. I think our main point is to find out whether artesian wells are a possibility with us at an expense within our reach, and should we ascertain that it is, to use that system with a series of ditches for irrigation. We have, however, large lake-basins there. I should think if dams were constructed systematically they would retain the superfluous moisture such as we had in the winters of 1880 and 1881, and that the waters might be led off by the outlet; so that if dams were used there are several streams that could be made available for irrigation.

The CHAIRMAN. Does the water remain long enough so that sufficient would be retained in the wet season to be used in the dry season?

Mr. YOUNG. I think so.

The CHAIRMAN. So that if you had had a dam constructed 5 or 6 years ago, the water would not have evaporated so much but that you would have water enough left for this year?

Mr. YOUNG. That is my opinion.

The CHAIRMAN. What is the average amount of rain-fall in your county for the last two years?

Mr. YOUNG. I have no figures.

The CHAIRMAN. Have you any idea how much it was this year?

Mr. YOUNG. About 23 or 24 inches, perhaps. As a matter of fact however, our county has been more favorably situated this summer because of its moisture than the county just west of us—indeed than a whole strip of counties. Then, too, our county has a greater water

area. Perhaps the larger amount of water-covered area is the cause of our having received a larger amount of rain-fall.

The CHAIRMAN. You have no means of knowing where this quartzite belt extends through the country, except these developments above here?

Mr. YOUNG. I have not made any survey, of course, and do not know.

The CHAIRMAN. It comes to the surface here?

Mr. YOUNG. Yes.

The CHAIRMAN. Does it come to the surface anywhere else north of here?

Mr. YOUNG. I think it does, some miles northeast of here. I am something of an amateur in geology, and have read somewhat in that science; and it seems to me that the outflow of the molten mass through an extended fissure—

The CHAIRMAN. I do not think it was ever a molten mass. I think it was a sedimentary mass.

Mr. YOUNG. Then it was surely metamorphosed by extreme heat.

The CHAIRMAN. We do not know that that is so. There was probably some action of gases that operated upon it.

Mr. YOUNG. I have not any data by which to determine whether it would interfere with our getting water for irrigation.

The CHAIRMAN. It appears to me very much like sedimentary rock, and I do not think there was any fire action about it. It is pretty expensive drilling through that to get water.

Mr. YOUNG. Yes, it is.

STATEMENT OF E. H. JACOBS, OF MADISON, LAKE COUNTY.

The CHAIRMAN. What do you say as to whether irrigation is needed in your county or not?

Mr. JACOBS. I do not know that I could say anything more than the other gentlemen have said, excepting about the character of the soil. I started a well.

The CHAIRMAN. Tell us what you went through, in digging that well.

Mr. JACOBS. We struck yellow clay at about 3 feet. We found that that yellow clay was some 50 feet deep; we then struck a blue clay that went down about 100 feet further. After that there was a white and yellow clay as far as we went. We went down some 330 feet, and did not strike anything but clay all the way along.

The CHAIRMAN. Where did you sink the well?

Mr. JACOBS. A mile north of Madison.

The CHAIRMAN. I wish you had put that well down about 1,000 feet. We would like to know something about the character of the ground there.

Mr. JACOBS. If I had gone down 1,000 feet I believe I should have flooded the whole town. [Laughter.]

The CHAIRMAN. You did not strike any of this quartzite that they have here?

Mr. JACOBS. No, sir; we did not strike a stone of any kind.

The CHAIRMAN. Do you think you were in the range of that, so that you would be likely to strike it?

Mr. JACOBS. I do not know anything about that. I had confidence that I should get water before I should strike that.

STATEMENT OF W. E. HOWE, OF MADISON, LAKE COUNTY.

The CHAIRMAN. What have you to say, if anything, on the subject of irrigation, and the need of it in your county and in your section of the country generally?

Mr. HOWE. I do not know that I can add very much to what has been said by the other gentlemen. We have a soil there that is very productive if a proper amount of moisture could be had. Instead of raising 10 bushels of wheat to the acre, we could raise 25 bushels, and all the way up to 40 bushels, I think. I have seen irrigation as it was practiced in the western country somewhat.

The CHAIRMAN. What part of the country did you see it in?

Mr. HOWE. I saw it up in Montana. The soil in our county is very variable. **Mr. Jacobs** has told you what he struck on his farm. If he had been down on my farm, south of Madison, he would have struck gravel almost immediately. Gravel presents itself down a foot or two; at least, so far as I have dug down that is the case. He would have found gravel and coarse sand. The subsoil is underlaid 4 feet with this solid cement or marl formation. Four feet further down he would have got another stratum of those, and he would have to go through them with a pick. I have not been down more than 10 feet.

The CHAIRMAN. That marl substance will hold the water, will it?

Mr. HOWE. Yes; it is the worst thing in the world to have around. The water will go down through the subsoil and through the gravel to that marl and then run right off through any opening it might reach.

The CHAIRMAN. That may be a bad thing for a town, but it is a good thing for a farm.

Mr. HOWE. You are quite right. If you could get in our locality a good snow-fall or an extreme amount of rain, it would fill up that place and would last four years.

The CHAIRMAN. Do you know any way of irrigating that country except by artesian wells?

Mr. HOWE. No way that I know of doing it on any extensive scale, except by artesian wells. The water would have to be raised either by wind power or some other power before it could be utilized.

The CHAIRMAN. You have seen irrigation practiced. Do you not think that in this country, with this marl underneath the soil, a ditch or stream on this side-hill would sub-irrigate for a considerable distance?

Mr. HOWE. Yes; I think that would be very good for irrigation. If a man could fill his farm up it would last him for three years, very nearly. That soil acts like a sponge. We had, three or four years ago, a rain-fall lasting for pretty nearly six weeks, and we had a great harvest as a consequence, because the subsoil had taken up so much water the previous winter.

Adjourned.

ON TRAIN, NEAR HURON, *August 3, 1889.*

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF C. B. McDONALD, OF DE SMET, KINGSBURY COUNTY.

The CHAIRMAN. What experiments have been made with artesian wells in your county?

Mr. McDONALD. None.

The CHAIRMAN. What is the condition of crops this year in your county?

Mr. McDONALD. In the western part of the county the crop is a total failure. In the northeastern corner there is a fair crop, and in isolated sections there is a good crop.

The CHAIRMAN. Those are the sections, I suppose, in which there is most moisture?

Mr. McDONALD. Yes, sir.

The CHAIRMAN. Where is the nearest artesian well to your place?

Mr. McDONALD. At Huron.

The CHAIRMAN. Are you on the divide between the Sioux and James River?

Mr. McDONALD. We are. We are in the James Valley.

The CHAIRMAN. Is there much of an elevation between the Sioux and the James?

Mr. McDONALD. Yes; there is a pretty high point.

STATEMENT OF L. L. BANCROFT, OF MANCHESTER, KINGSBURY COUNTY.

The CHAIRMAN. Where is Manchester?

Mr. BANCROFT. Nine miles west of De Smet.

The CHAIRMAN. Have you anything to say in addition to what Mr. McDonald has said with regard to your county and the need of irrigation there?

Mr. BANCROFT. Nothing in particular, only that we would be glad to ascertain whether we can have a good supply of water there. Our crops in part of the county have been very small; we have had hardly a piece of a crop, even; we have had some corn.

The CHAIRMAN. Have you had some recent rains here?

Mr. BANCROFT. Yes, sir.

The CHAIRMAN. At what time did you have the first rain?

Mr. BANCROFT. I believe about the 6th or 7th of July. About two weeks after that we had another rain, and we have had quite a number of rains since that time.

The CHAIRMAN. The rain did not come, however, in time to save your small grains?

Mr. BANCROFT. No; one man on 12 acres of land got 24 shocks of grain. The grain is shrunken very much. In the northeast part of the county, however, there is some fair grain.

STATEMENT OF J. D. PEIRSON, OF DE SMET, KINGSBURY COUNTY.

The CHAIRMAN. What have you to say in addition to what has been said by these other gentlemen in regard to your county and its need of irrigation?

Mr. PEIRSON. I do not know that I have anything in particular to add to what has been said except that our crops were saved by a local rain through the northern part of Kingsbury County, along about the 1st of June. Our crops would have been a total failure if it had not been for that rain. North of that the crops have been a total failure, and also south. I am a cattle dealer, and have been all over the county, so that I know the condition of things pretty well.

The CHAIRMAN. Is there anything peculiar in your section of country with regard to the rains?

Mr. PEIRSON. The tendency of the storm I have spoken of was toward the northeast. It was between Spirit Lake and Lake White-wood and Lake Thompson. Between those places the crops were good, and southwest of those places the crop was an entire failure. Then further on—northeast of this line—the crops are a failure. I have been over the section repeatedly.

The CHAIRMAN. How far up the Missouri River have you been?

Mr. PEIRSON. I have been up as far as Fort Benton.

The CHAIRMAN. Have you ever contemplated the possibility of at some future time having a canal very high up on the Missouri River, and bringing it down here?

Mr. PEIRSON. I have not, sir.

The CHAIRMAN. What would be the effect here of a canal, having plenty of branches, so that there would be a sufficient supply of water for this country about here?

Mr. PEIRSON. It would be a very great thing for this country. Our country here has a number of ravines running through it, so that if we could have it well supplied with water the ravines would distribute the water thoroughly.

The CHAIRMAN. You have never practiced irrigation at all in this neighborhood, by digging ditches to bring the water on the land?

Mr. PEIRSON. Not that I know of.

The CHAIRMAN. What is the character of the soil in this section?

Mr. PEIRSON. It is a black loam, from 12 to 24 inches deep, underlaid in most sections by clay; In some small parts of the country, perhaps a mile wide, our coteaux are underlaid with gravel and sand; you can then go down from 20 to 40 or 50 feet, when you strike blue clay.

The CHAIRMAN. This blue clay holds the water that you get, does it not?

Mr. PEIRSON. Yes, sir; it holds the water very well. Two or three years ago we had quite a number of wells that were from 15 to 18 feet deep, and those wells have now gone dry, and many farmers can not get sufficient water to feed their stock. Many of them have been marketing their cattle, on account of the scarcity of water.

Senator REAGAN. Has there been an unusual absence of rain in this part of the country for a number of years?

Mr. PEIRSON. There has been an unusual absence of it in the last three or four years.

Senator REAGAN. What is the topography of the country that you speak of; are the lakes in low depressions, or are they pretty well up?

Mr. PEIRSON. Spirit Lake is on the divide between the two rivers; it is as high as any point about here, I think.

Senator REAGAN. How about the other two lakes?

Mr. PEIRSON. They are on the same level very nearly, but a little lower.

Senator REAGAN. Are they higher than the valley at large?

Mr. PEIRSON. Yes, sir; our country is a little undulating, and these lakes are in the low places. There are outlets to most of them, but on account of having so small an amount of rain they have run down below the outlet, so that these lakes are dried up.

Senator REAGAN. All around these lakes are the crops pretty good?

Mr. PEIRSON. Yes, sir.

The CHAIRMAN. Could you not use those lakes to some extent by damming them and keeping water in the ditches?

Mr. PEIRSON. Yes, if we had the accommodations for holding the water.

The CHAIRMAN. In the wet season could you not do it to some extent?

Mr. PEIRSON. Perhaps we could to some extent; but we haven't any reservoirs to hold the water. Seven years ago we had water enough to fill up all these lakes, and for the next two or three years we had an abundance of crops.

STATEMENT OF J. B. MACDONALD.

The CHAIRMAN. What have you to say to the committee with respect to the subject of its inquiry as affecting the section of country about here?

Mr. MACDONALD. I simply wish to speak of the desirability of some kind of survey or investigation here to satisfy the people that irrigation by artesian wells is practicable. I am satisfied that our counties here are amply able to carry on a system of irrigation after they are once convinced that it is practicable and that the water can be had. During the first two or three years of settlement here the people had excellent crops of every description, but the last two or three years the crops have been almost a total failure. If the Government would give us experimental wells or some means of knowing how to get wells it would encourage our people very much to carry on the work themselves.

The CHAIRMAN. I would like to see some experimentation done, but the Government of the United States is hardly prepared to go on with a system of digging wells. We do not know what they can do in the future, but we are now trying simply to get the information, and perhaps we may afterwards be able to get some wells dug.

Adjourned.

HURON, S. DAK., *August 3, 1889.*

The committee met, pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF LEWIS McLOUTH, OF BROCKING.

The CHAIRMAN. What is your position, Mr. McLouth?

Mr. McLOUTH. I am president of the Dakota Agricultural College and director of the United States Experimental Station. Both are located at Brocking, east of this city. With your permission I will read a paper I have prepared on "Irrigation by means of artesian wells."

The CHAIRMAN. Go on.

Mr. McLOUTH. The valley of the James River, from Yankton on the south, to Jamestown on the north, is more than 300 miles long, and, reckoning it 40 miles wide, it covers an area of more than 12,000 square miles—over 7,000,000 acres.

The soil is very deep and fertile, and the surface is so even and unbroken that almost a continuous furrow could be plowed from Yankton to Jamestown. It is a safe estimate to make that 99 per cent. of this entire region is arable land. It is destitute of timber, except occasional strips along the channel of the river. Few living affluents flow into this river from source to mouth, and the volume of water seems hardly to change for hundreds of miles of its sinuous course.

Nearly all the land in this valley is occupied and much of it is under cultivation by an industrious and frugal class of farmers, while thrifty cities have been founded and are growing up along the banks of the stream and at the various railroad centers. The unplowed lands are covered with exceedingly nutritious wild pasture grasses, and the crops of wheat have heretofore almost rivaled in quality and amount those of the famous Red River valley of North Dakota. The soil is also well adapted to the growth of barley, oats, and rye. Corn, especially in the south half of the valley, has been found to grow and ripen well, while potatoes, turnips, and other root crops grow luxuriantly, as in all parts of Dakota.

With favorable climatic conditions this valley might become as productive as any in the world, and support a dense and thrifty population. The climate is salubrious and invigorating. The winters are cold, but not long, and the almost continual sunshine of summer, made more active and intense by an average elevation above sea level of near 1,400 feet, brings forward vegetation with great rapidity and luxuriance.

Although trustworthy meteorological observations have not been made for this region long enough or in places enough to give absolutely reliable data, the best information obtainable indicates that 20 inches per annum is about the usual rain-fall, and that three-fourths of this amount falls during the five growing months of April, May, June, July, and August. The remaining five inches is made up by the scanty later fall rains, the earlier spring rains, and by the snow-fall of winter.

When the 15 inches of summer rain-fall is properly distributed through the growing months good and abundant crops are assured; but when, as during the present season, the scanty average is diminished, or when, as last year, it is bunched into April and May, while June and July, with their hot south winds, are almost rainless, then

the growing grain is parched and withered and only yields half a harvest.

The region is so far west that the return trade-winds from the south-west come to us robbed of their watery vapor by the high mountain ranges over which they have passed, and about the only supply of rain is that which is brought to us from the Gulf of Mexico by the return trades, deflected far to the west by the heated plains that skirt the eastern slopes of the Rocky Mountain system.

It is probable that no modification that man can effect with the earth's surface or its coverings can ever change these fundamental climatic conditions. The controlling causes are so radical, are so dependent upon the great continental contour and relief, and upon the very form and motions of the earth itself, that man is utterly impotent to effect any change whereby the watery precipitation can ever be greatly increased in the remoter western regions east of the mountains.

There has been general talk about the effect of tillage and tree planting to increase the rain-fall; but the most careful observations have given no evidence thus far of any such increase.

But while man's work is probably unavailing to procure any measurable increase of rain or snow, still his modifications of the surface conditions of the earth are by *no means* powerless to work such changes in his climatic surroundings as shall better fit them to his wants, his comfort, and his convenience.

The tough original turf of the prairie is almost impervious to water, and sheds the rain-fall almost like a thatched roof, so that the water that falls upon it runs right off along the "draws," and temporary streams soon become dry again. But when these prairies are plowed the loosened and porous sod takes up and holds a supply of moisture to bud vegetation.

These blacked plowed fields also in late winter and early spring draw and absorb the rays of heat from the sun, and thus melt off the snows and absorb the water, while the unbroken prairie is still covered with a white mantle of snow.

The plowing doesn't increase the rain-fall any, but only tends to hold and distribute it, to feed the springs and streams more slowly but longer.

The growth of such crops as wheat and corn upon the cultivated prairie shades the ground and holds back the moisture by preventing rapid evaporation.

Trees do the same still more completely, and will also in time check the dry hot winds from the south, as well as the blizzards from the north.

All of these agencies, while not increasing the rain-fall, tend to distribute it more evenly throughout the growing season, and to husband and utilize it more completely.

That this change is being effected is well enough attested by the fact the blue grass is working its way westward year by year with the advance of settlement, and supplanting the original bunch prairie grass. The blue grass requires a more continuous and regular supply of moisture than the original prairie grass that can thrive on the arid soils.

With these we need ask bountiful mother nature for nothing more. If we can have water the trees will come quickly; if we can have the trees they will protect our water supplies from waste and distribute the vitalizing summer showers throughout the growing season.

But since the dawn of historic times men by their own means have been able to water dry and arid regions by the devices of art and so convert deserts into gardens. Rivers—ordinary rivers—have usually

been the sources of this artificial water supply, but in this wonderful new West men not only think new thoughts, but nature manifests herself in wonderful new ways.

All over this belt of country first referred to, 40 miles wide, west of this Little James River, and for a longitudinal distance of nearly 400 miles nature seems to have provided a water supply unlike any ever heard of before. Hundreds of artesian wells all along this valley, wherever sought, from Yankton to Jamestown, attest the presence of a subterranean water supply seemingly inexhaustible in quantity, and at a depth below us varying from 500 to 1,500 feet; whence its source nobody can tell. At Jamestown this strange water supply is found to be near 200 feet below the sea level, at Huron it is more than 400 feet above that level, and at Yankton still higher. Thus while the James River flows to the south, this great underground stream seems to have its descent in the opposite direction. The wells that tap this great reservoir flow with a force that varies from a pressure of 50 pounds to the square inch to 200 pounds. The power is used to run electric-light dynamos, brick machines, mills, factories, printing presses, etc. Some of these wells yield, through a 6-inch tube, the enormous amount of 4,000 gallons of water, or more than 125 pounds, per minute.

Neither the pressure nor the amount of flow seems to diminish with the multiplication of the wells. In the city of Yankton, two years ago, there were fifteen of these wells, and thirty within a radius of 20 miles, and yet no cessation nor diminution of flow. Now, naturally enough, it occurs to the mind of every thoughtful man, especially when his fields are parched and his grain is withering, whether this inexhaustible subterranean reservoir of water may not be made to supply the lack of rainfall.

An easy arithmetical estimate shows that one of these wells, yielding 500 cubic feet of water per minute, would supply enough in a year to flood 20 square miles to the depth of 6 inches. Or, in other words, if the yearly flow of one of these wells could be saved in reservoirs and drawn out at pleasure, it could be made to increase the summer rain-fall of 15 inches to 21 over an area of 20 square miles of land, while the supply could be so regulated as to remedy the defects of nature.

Much of the region under discussion is so level that irrigating ditches could be carried long distances and made to serve wide areas. In other places the numerous dry lake-beds would serve as natural reservations, from which it could be drawn by irrigating ditches, or pumped by abundant, inexpensive wind power. A thousand of these wells would easily water this entire valley and convert its area into a most luxuriant garden. Not 6 inches of water, but 1 or 2 of them, just at the right time, when summer showers fail, would be sufficient to insure certain and abundant crops.

The money value of a single quarter-section of land, by such a supply of water, would at one advance from \$1,600 to at least three times that sum, an advance amply sufficient to cover the cost of the well. The added value of the lands of the James River Valley would not be less than \$40,000,000. Neither should be left out of the account the untried but probable effect of such open reservoirs of water upon the climate of adjacent regions. Such watered areas with the timber belts that would soon and inevitably spring up, would most certainly have a wonderful effect upon the rain-fall of neighboring regions while the asperities of our summer heats and our winter cold would be greatly ameliorated wherever the influences of this new condition of things should extend.

The average cost of the wells already bored—including the piping—has, according to best estimates, not varied much from \$4,500. Now, if it were necessary to provide a well at this cost to properly irrigate each square mile, the added value of the one section of land would at once pay for the well with a 50 per cent. surplus to boot. But it is probable that if the boring of such wells were entered upon systematically their cost might be reduced to less than half the sum named already.

But why, it is asked, if such expenditures would so rapidly advance the value of these lands, does not the private enterprise of the owners of these lands enter at once upon this work? The answer is not far to seek. The settlers of this valley, like most of this new Northwest, are poor men, who came here within the last ten years, attracted by the offer of free lands, bringing with them little capital except their wives, young children, their clear heads, sturdy muscles, and willing hands. They are in debt, too, often, for their houses, their teams, and their farm machinery. Poor crops for the past two or three years, and a poorer one promised this year, leave them utterly unable to undertake the improvement now under discussion.

The enterprise is indeed one of such extent and one of so much promise of beneficence that national aid should step in to assist private effort. Not the building of light-houses along the shores of the Great Lakes, as security to commerce, not river levees and dredgings, not credit loaned to railroads, nor lands given to them in fee simple, not subsidies to ocean steam-ship lines, nor canals for shortening the courses of trade, promise greater and more immediate benefits to that class of people who, while bearing the burdens of Government, have not always enjoyed to the fullest the fostering national care that is now promised in these initiatory steps toward the reclaiming of the arid lands of the West. Good natural economy, good statesmanship commend this effort. The disturbing "surplus" could not be put where it would do more good nor return better interest in binding more firmly to the National Government the loyal hearts of a struggling people.

The people of this valley could well afford to return to the national Treasury a million of dollars with good interest during the next ten years if by such national expenditure at the present time such beneficent results can be effected as the best-informed believe probable. The people of the two Dakotas have not been so gently cradled in the national lap for the last five years as to estop them from pressing their claim for the expenditure of a moderate part of the generous sum yearly appropriated for rivers, harbors, and other public improvements.

It is not necessary for Government to do anything more than make preliminary and testing surveys, and to try satisfactorily whether the proposed method of irrigation is as really feasible as circumstances seem to promise. As soon as possible after the plan is definitely settled the enterprise of this Western people, which has already done so much to reclaim a wilderness to civilization, will find its own way to carry out and complete the great work.

Senator REAGAN. One gentleman testified before us that an arrangement could be made for the sinking of 8-inch wells for \$2,500.

Mr. McLOUTH. Indeed; I was not aware of that. Some estimate that a well of 1,000 feet can be sunk for \$1,000.

Senator REAGAN. What you state there is the general estimate?

Mr. McLOUTH. Yes; that is the estimate I have made from the reports in my hands.

The CHAIRMAN. How generally are these wells distributed over this country?

Mr. McLOUTH. The whole length of this valley—400 miles—from Yankton to Jamestown.

The CHAIRMAN. Down to what depth have you extended them?

Mr. McLOUTH. It is a fact, but a strange one, that they are nearly all found on the west side of the river, and have been found within a strip 40 miles in width.

The CHAIRMAN. Have experiments been made on the eastern side?

Mr. McLOUTH. Yes. In the valley of the Sioux River we have tried a number of times, but we can strike no water; we strike the primeval granite.

The CHAIRMAN. You state that the source of this water supply is entirely unknown.

Mr. McLOUTH. Some think it is due to the upper waters of the Missouri, and some think it is fed by the melting of the snows beyond. It is an unsettled question as to whether it comes from one reservoir. The chemical analysis of this water differs so much in different localities, that one is led to think that it is from separate reservoirs, and its temperature is from 48 to 80 degrees.

The CHAIRMAN. What are the strata, I mean the formations, in which there is water?

Mr. McLOUTH. It is always found in sandstone.

The CHAIRMAN. Coarse sandstone?

Mr. McLOUTH. Yes; coarse sandstone, with shale or dense limestone as a capping above the reservoir.

The CHAIRMAN. About what is the thickness of that sandstone?

Mr. McLOUTH. I am unable to say.

The CHAIRMAN. Have they examined it at many points to ascertain that?

Mr. McLOUTH. I have it in a dozen reports. The capping rock, I am informed by Mr. Smith, is about 90 feet deep.

The CHAIRMAN. You mean the strata carrying the water.

Mr. McLOUTH. The water-bearing strata. There are a great number of artesian wells in Sanborn, the adjoining county to Miner; but they seem to be due to some other reservoir. They have found wells there from 50 feet to 150 feet, one bubbling in a marsh.

The CHAIRMAN. All I have seen of the valley is sedimentary formation.

Mr. McLOUTH. The primeval rock we strike at our place east of here.

The CHAIRMAN. Is there not some doubt about that?

Mr. McLOUTH. Yes.

The CHAIRMAN. We call that quartzite.

Mr. McLOUTH. Yes, that is it.

The CHAIRMAN. The well-men bore through one stratum of it and get the strata of clay or chalk about 40 feet thick. I do not think you get the primary rock there.

Mr. McLOUTH. I am in doubt about it. But it has been generally supposed it was the primary rock. It is a strange outcropping in such a region. In North Dakota they get artesian wells from another supply—in the east side. I do not know of any on the west of the river.

The CHAIRMAN. Have there been any experiments farther west of the Missouri River?

Mr. McLOUTH. I do not know.

The CHAIRMAN. You do not appear to be in much doubt here, from the experiments you have made, as to the result.

Mr. McLOUTH. There seems to be no diminution in the supply of water from the increase of the number of wells. Put them close together and they do not seem to affect each other.

The CHAIRMAN. That must depend upon the extent of the water supply, where it comes from, and the thickness of the strata bearing it.

Mr. McLOUTH. The pressure of the water seems greater at the north, where the wells are deeper, and diminishes at the south, where the wells are shallower.

The CHAIRMAN. May not that be governed somewhat by the weight of the overlying earth?

Mr. McLOUTH. I have not supposed that the weight of the earth was absolutely supported by the volume of water. If that were the case it would make a difference in the pressure.

The CHAIRMAN. That is, loose rock and the water being taken out, it would become more compact, of course.

Mr. McLOUTH. Yes.

Senator REAGAN. Wells have been successfully obtained east of the James River.

Mr. McLOUTH. Very close to the river only, but not at any great distance from it. They find them 40 to 50 miles west of the river. But, as a rule, if they are found on the east side, they are close to the river.

The CHAIRMAN. Is it a fact that where you bore the deepest the pressure is the strongest? Is that almost universally the case?

Mr. McLOUTH. Yes. The pressure at Columbia is 200 pounds to the square inch.

The CHAIRMAN. What is the depth of that well?

Mr. McLOUTH. From 1,200 to 1,500 feet deep—1,500 feet possibly. Some of the wells at Yankton are not more than 500 feet deep. The pressure here is 50 pounds and the depth only 900 feet.

The CHAIRMAN. I have wanted to know whether it was the depth of the well or the weight of the earth.

Mr. McLOUTH. The greater the depth of the well the greater the pressure. But the Jamestown well seems to be an exception to some extent.

Mr. HINTON. What is the average rain-fall or precipitation in this State—the average annually?

Mr. McLOUTH. I think it is 20 inches. When we get 20 inches during the summer season we are perfectly satisfied, and even 15 inches would be safe. If it is distributed 2 inches in April, 3 inches in May, 4 inches in June and July, and enough in August to ripen the corn and potatoes we do not care for rain after that. That insures a crop of the cereals and summer crops. We do not raise any winter grain.

Mr. HINTON. The reported average report is 22 inches.

Mr. McLOUTH. They say 22 inches in their reports. Probably they know better than I do, but I compute it at 20 inches. There have been but few meteorological stations that have carried on observations for any length of time.

Mr. HINTON. How long have you carried on yours?

Mr. McLOUTH. Only two years, and they have been making observations fifteen months.

Analyses of artesian waters in Dakota, furnished by Mr. McLouth.

JAMESTOWN.

[Organic matter: Free ammonia, 2.4 parts per million; albuminoid ammonia, 0.46 parts per million; nitrites, traces; nitrates, none.]

INORGANIC MATTER.

Silica	35.70	2.0823
Alumina	3.50	.2041
Carbonate of iron	2.20	.1233
Carbonate of lime	188.00	10.7643
Sulphate of lime	249.00	14.5243
Sulphate of magnesia	154.20	8.9944
Sulphate of soda	1,139.40	66.3602
Chloride of sodium	369.10	21.5296
Sulphate of potash	81.05	4.7526
Phosphates		a trace.
Hardness		21

Yankton.—Water slightly hard; pleasant to the taste; is used in boilers and gives good satisfaction.

Higmore.—Water very soft and of good quality.

Müller.—Water excellent, and good for all purposes.

Ipswich.—Water very soft; contains soda, potassium, and allied salts; tastes slightly brackish.

Columbia.—Water contains mineral properties; very soft.

Grafton.—Three per cent. of salt in water and slightly trace of sulphate of magnesia.

Ellendale.—Water not pleasant to the taste; very soft.

STATEMENT OF CHARLES S. FASSET, OF HITCHCOCK, BEADLE COUNTY.

Mr. Chairman and gentlemen, my town is situated 20 miles from here, on the county line.

The CHAIRMAN. Explain the situation in your section touching the question of moisture. Have you a well at Hitchcock?

Mr. FASSET. Yes.

The CHAIRMAN. How deep is it?

Mr. FASSET. It is 965 feet deep.

The CHAIRMAN. What is the size of the bore?

Mr. FASSET. The bottom of the bore is $3\frac{1}{2}$ inches. They started with a $4\frac{1}{2}$ -inch pipe, and used it until they struck a strata of quicksand, which bound the pipe, and they set another pipe in that. By the breaking of the machinery they had to put in another pipe, so that when they reached the sand rock at the bottom it was $3\frac{1}{2}$ inches in size.

The CHAIRMAN. Do you know the stratification through which the drill passed?

Mr. FASSET. Some clay, sand, shale, and rock over these—porous sand rock. My recollection is that it was from 6 to 9 feet deep. We went through that into what would be like a honeycomb sand rock, and we secured a nice flow from that depth.

The CHAIRMAN. What depth was that?

Mr. FASSET. Nine hundred and thirty feet; but it was concluded that we should go somewhat deeper; so we bored down into this porous sand rock from 30 to 35 feet, and it gave us more flow. I think we have the best well in the James River Valley, and we got it by going down that depth. The flow from the well the first few hours contained sand, but after that it was quite clear. After three or four days the water was clear and then it commenced to spit sand again, and that continued for nearly a week. We could hardly see the water for the sand which came through the pores of this rock; but after a week or ten days that all cleared away.

The CHAIRMAN. What is the pressure you obtained from that well?

Mr. FASSET. That has not been decided properly. The first three attempts the pressure was so great that it broke the gauge. Afterward we brought an expert there, and he stated the pressure to be 218 pounds to the inch. The last test, I think, was made by some expert in company with Augustin Davis, and they concluded that it was 186 pounds. Recently, some distance from the well, they have made it 156 pounds. They estimate that from this little well, where there is a 35 horse-power motor, as they termed it to me, running the machinery.

The CHAIRMAN. What number of gallons per minute is discharged? Has that been estimated?

Mr. FASSET. That has not been estimated.

The CHAIRMAN. Have you used any portion of that water for irrigating the land?

Mr. FASSET. Last year there was a test made on Sheffer's lot. That was an acre of land. Water from the main was thrown over that. That gentleman had sowed some timothy and clover, and had planted some trees in the lot, and by request the water was tested by throwing it over the ground from the hydrant that I think he had in his yard at that time, and the timothy came up from about $2\frac{1}{2}$ to $3\frac{1}{2}$ feet. Those pipes or mains that run through the streets there are 6 feet deep. There are pipes running out to the residences on each side. Sometimes these pipes would break and fill this subsoil with moisture. In the yards there to-day where the moisture has gotten into the subsoil under the trees they have made them grow from $3\frac{1}{2}$ to 4 feet. That was so of box elder. In yards where it does not reach the subsoil the leaves are yellow and drop off, and some of the trees seem to be dying.

During last winter there was a water-course dug from the well east for 6 miles, to carry the waste water from the mill that was located there this spring. In running this ditch, the lowest ground was that which had a fall toward the south, to Moore Lake. There was no effort made to keep this water up, and so far as that water extends there is a beautiful strip of grain country. On one side is grain and on the other side is grass. In places where this ditch goes the water comes within a foot of the surface; in other places it is in depth from $2\frac{1}{4}$ to 3 feet. The ditch filled this spring and overflowed that tract of country. The water was afterwards drawn off and crops were put in; and to-day they are harvesting those crops, which are from 25 to 50 per cent. greater than where this water has not been.

And in that connection I would like to say this: The hot winds that swept over that spot in the spring did not affect the grain at all. The wheat is filled to the top on each side of this ditch for $2\frac{1}{2}$ to 5 rods, and all who have seen the grain estimate that the yield will be from 50 per cent. to 100 per cent. greater than where there has been no moisture from this water.

The water that is in this ditch that extends to the lake, 6 miles away, is the waste water from a mill. Then we have west of the town, supplied by the well, a lake which covers an area of from 40 acres to 60 acres. This lake is from $7\frac{1}{2}$ inches to 1 foot deep. In addition there is flowing from our well a constant stream running to a small pond there. They found over in that section that they could get a greater amount of water to flow east, and that it would pass over some sand and gravel. There is probably no time except for a few hours that the well is allowed to discharge more than one-half of what it is capable of doing.

The CHAIRMAN. Have you thought how to economize that water and run it into ditches so that it would percolate through the soil and satu-

rate the entire ground sufficiently to moisten it for crops? Have you ever estimated how much land you could reclaim by that well?

Mr. FASSET. We are always estimating, but no two of us think alike. My idea is that we do not need nearly as many wells as has been generally supposed. The flowing of that well and soaking up of that sub-soil showed me that if we could get this land filled with water we would not need to flood it every year; we would need to put the water on only once after our grain was put in the ground and once just before it was harvested. That is my idea. Taking that as a basis for my calculation I would say that this small well that we have there would irrigate four or five sections and furnish this flow. Certainly we could make a nice lake out of two sections, and keep it supplied with water if we turned our water in that direction. We are utilizing that water there for a feed-mill and flour-mill.

TABLE OF PRECIPITATION.

The following was received and ordered filed by the chairman:

Statement showing monthly, annual, and average precipitation in inches, as recorded at the U. S. Signal Office, Huron, Dak.

Month.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	Total by months since station opened.	Average by months.
January.....		0.14	0.17	0.09	0.15	0.48	0.33	0.78	1.26	3.40	0.425
February.....		0.25	0.47	0.58	0.22	0.16	1.11	0.52	0.03	4.24	0.530
March.....		0.80	0.42	1.53	0.12	0.62	0.64	1.22	0.19	5.54	0.692
April.....		4.18	2.14	2.70	1.06	3.52	3.72	0.88	3.41	21.61	2.700
May.....		4.50	4.45	2.90	5.20	1.58	1.39	4.98	3.04	28.04	3.505
June.....		5.86	4.33	3.18	5.43	1.90	3.98	1.10	1.04	26.82	3.352
July.....	*3.58	5.88	5.20	5.11	4.52	1.60	4.96	3.11	3.51	37.47	4.163
August.....	6.31	1.44	1.77	1.18	3.89	5.62	6.13	3.46	.....	29.80	3.725
September.....	3.11	0.86	1.68	1.26	2.61	1.59	0.15	0.19	.....	11.45	1.432
October.....	2.10	3.37	1.96	1.52	0.98	1.26	0.79	0.29	.....	12.27	1.534
November.....	0.45	0.61	0.05	0.17	1.50	1.18	0.25	0.34	.....	4.55	0.569
December.....	0.06	0.23	0.61	0.62	0.10	0.74	2.09	0.18	.....	4.63	0.579
Total....	15.61	28.12	23.25	20.84	25.78	20.25	25.54	17.05	13.38	.....	.....

* Station opened July 1, 1881.

Inches.

Total seven complete years 160.83

Average seven complete years 22.98

A true copy.

SAM W. GLENN,
Sergeant Signal Corps, Observer.

STATEMENT OF CHARLES J. AMBROSE, OF HURON, BEADLE COUNTY.

The CHAIRMAN. What is your occupation?

Mr. AMBROSE. I am clerk in the United States Government land office.

The CHAIRMAN. How much of a section does your district cover?

Mr. AMBROSE. Eight counties.

The CHAIRMAN. How many acres are there in those eight counties?

Mr. AMBROSE. Six million eight hundred thousand acres.

The CHAIRMAN. What portion of it is now public land?

Mr. AMBROSE. I should think about one-fifth at this time.

The CHAIRMAN. Something over 1,000,000 acres?

Mr. AMBROSE. Yes, sir.

The CHAIRMAN. Is the land that is not yet entered suitable for entry?

Mr. AMBROSE. There is some of it that is, but some of it is not. Some of it is very rough land.

The CHAIRMAN. Is it hilly or level?

Mr. AMBROSE. It is principally hilly land.

STATEMENT OF PHILIP SKILLMAN, OF ABERDEEN, BROWN COUNTY.

The CHAIRMAN. Give us whatever information you have with regard to your locality, your artesian wells, and the effect of them, and the condition of your country about here as to the requirements for more moisture for agricultural purposes.

Mr. SKILLMAN. I would say in the first place that we have a county 36 miles by 48 miles, containing a little over 1,000,000 acres. All of that is available for tillage and for crops.

I indorse substantially all that was said by Professor McLouth, although in some respects I think he was in error—for instance, with reference to the artesian basin within which these wells may be had. There is a range of coteaux extending up and down the eastern part of Dakota covering perhaps 50 miles in width. Then you begin to descend the Jim Valley. The valley is about 40 to 50 miles wide. But I would also extend this area all the way over to the Missouri River. I think that would be found all the way to the river. The wells are of the same average depth. Our elevation above the sea level is a trifle over 1,300 feet. There are five or six wells in our county, and we strike water at a level of about 900 feet in depth. Then as you go east or west the surface rises, so that you have to go so much deeper in order to reach that water-bearing rock, the sand-rock. There are three wells in Aberdeen, another in Columbia, another in Groton, another at Ipswich, and one or two others in the county.

The CHAIRMAN. Do they all strike water about the same level?

Mr. SKILLMAN. About the same average depth.

The CHAIRMAN. Do you mean the same average vel?

Mr. SKILLMAN. Yes, about the same level. In going down they go through just about the same strata. I have the data here as furnished to me by those who put down those wells.

The CHAIRMAN. We would like to have the particulars of the strata.

Mr. SKILLMAN. At Aberdeen we find the strata as follows:

	Feet.		Feet.
Surface	16	Blue shale	375
Blue clay	78	Sand	10
Shale	400	Shale	15
Limestone	10		

At that point we strike what is called the water-bearing rock. On the top of this water-bearing rock there is a hard rock, almost like granite, something like 10 or 12 inches thick; then the rock begins to be a little more open and porous.

The CHAIRMAN. What is the color of that rock?

Mr. SKILLMAN. About the color of ordinary sand—a light color. After getting six or eight feet into that rock the water begins to flow. How far that formation extends throughout the country I do not know, but I know of no well where the drill has gone into that sand rock over 50 feet.

The CHAIRMAN. You have not gone into it in your section at all.

Mr. SKILLMAN. No; I do not know of any place in Dakota where they have gone through it. We have three wells at our place, and they are all of about the same pressure. The constant pressure is not far from 180 pounds to the square inch. I have seen the pressure, however, at 220 pounds. It sometimes varies without any apparent cause therefor. When there is but a small stream running the gauge will show a change of from 15 to 20 pounds to the square inch. My idea is that that is due to a pressure of gas. I think this pressure comes from the fact that the water is brought at some point into contact with natural gas. In fact, in some places, as they have gone down, gas has escaped with the water.

Senator REAGAN. Has that gas ever been ignited?

Mr. SKILLMAN. Yes; I understand it has. It sometimes comes up with the water, and then the people run a pipe into a barrel and make a place for the water to escape on the other side, so that there may not be a vacuum in the top of the barrel. Then enough gas will escape so that a little flame will burn at the top of the barrel.

The CHAIRMAN. You said that you thought that this artesian belt might extend to the Missouri River. Is there any reason to suppose that it stops there?

Mr. SKILLMAN. No; I believe it goes to the Black Hills. And I believe that the source of our water supply is in the foot-hills of the Rocky Mountains. A Professor Moore, who was in our place in 1883 or 1884, to examine our wells, told me that he had had charge of an appropriation, made, I think, by the Government for the sinking of Government wells in Colorado—I am depending on my memory now. He had made a study of the geology of the countries through the West, and had made a study of our place and other places in Dakota. I asked him whether the source might not be east of us, or whether it might not be north or west of us. His reply was—"This sand-rock which you find here undoubtedly extends out to the Black Hills. There has been a volcanic eruption which has turned this rock up edgewise." I asked him how long the water supply was likely to continue, and his reply was that as long as snow fell in the Rocky Mountains, just so long would the supply remain good.

The CHAIRMAN. Have you ever been up in the Rocky Mountains?

Mr. SKILLMAN. No, I have not been there. I will say that we were, to a certain extent, in Brown County, the pioneers in this movement of artesian wells. The first wells were put down by the railroad company, but the first for ordinary uses were put down by our city. Its wells have been there since 1882, and give no signs whatever of exhaustion. There was not sufficient fall in order to carry off our sewage, and a well was put down, and another pitch was made, so that it was sent to adraw that carried it off into the James River. That is the third well we have there.

The rock is porous and sponge-like. In some places, however, the sponge part is very frail, and will break off pretty soon. In other places the sand-rock is so that it remains together, and throws out almost pure water. The first well that the city put down, and the railroad well also, threw up great quantities of sand. I think there must have been first thrown up three or four hundred car-loads of sand. That would run clear for perhaps three, or four, or five months, and then sand would begin to come, and we would have to throw it open and exhaust the sand again. That would vary in different localities, but the same distinguishing features remain in reference to them all. It is said that the water varies in different localities, and that is so. In Brown County

the water is very soft. In other places it is very hard. My idea is that it receives local coloring from the ground through which it passes.

Senator REAGAN. We have had the statement made here that the first water coming through one well was soft and that at a lower depth the water that came from the same well was hard; so that the same well brought up different characters of water, according to the stratum from which the several varieties of water came.

Mr. SKILLMAN. I am not aware that there are different strata, in reference to this matter, in the James Valley. There are two or three depths which are reached going down where water sufficient, perhaps, to get to the pipe will be found.

Senator REAGAN. That is in the artesian vein proper?

Mr. SKILLMAN. Yes.

The CHAIRMAN. Have you observed with care the "capping" or the rock that lies over the water-bearing rock? Might it not, in one place, contain more lime than the capping in another place?

Mr. SKILLMAN. I only know by what the men have told me who have been putting down the well. They told me what their drill struck.

The CHAIRMAN. But the character of the water on the rock would probably be governed somewhat by the character of the rock that contains the water, not perhaps so much in the rock itself, but if the water had a casing of a different material it would be affected by it. This sedimentary rock is sometimes lime and sometimes something else; occasionally it is slate.

Mr. SKILLMAN. Yes. But here are all these strata that are above this water-bearing rock.

The CHAIRMAN. I allude to the casing or stratum that is just over it. The casing of the material in that stratum might make a difference in the water.

Mr. SKILLMAN. Yes; I think it might.

The CHAIRMAN. I have found a change in such water. It was either harder or softer in some cases, and by examining the casing of the water-bearing stratum it was found, or at least believed, that that was what made the difference. Of course, the water is pressed very hard against the casing. Slate and limestone are so much alike, and formed in so much the same way, that the casing might gradually taper off from limestone into slate, or *vice versa*.

Mr. SKILLMAN. Yes. I will say here that this shale is somewhat like stone, but as you expose it to the air, you can crumble it up with your hand.

With reference to the capacity of the wells, and as to whether the flow of one well affects the flow from another, I will say that one of our wells is 300 or 400 feet away from the other and does not seriously affect it. When we open one well it will perhaps affect the other by a matter of 10 or 12 pounds pressure, so that there is something like communication between the two wells.

The CHAIRMAN. From the description of the thickness of this sandstone that carries the water—if it be a fact that the sedimentary rock extends to the Rocky Mountains, as you think it does, and that it runs north and south so that it receives the snow from that great water-shed and extends for a long distance—if that be correct, then you have a supply of water that you can not exhaust, for artesian wells depend upon supply and demand, just the same as other things.

Mr. SKILLMAN. I got the analysis that was made of our water, showing only a trace of organic substance, which would seem to indicate that it did not come from lakes or anything of that kind.

The CHAIRMAN. Did Mr. Moore state to you the experiments which led him to the conclusion that this sand-rock led from the Rocky Mountains down?

Mr. SKILLMAN. I can not say that he gave me any reason for his statement or conclusion in that matter; if he did I don't remember it; I do remember, however, that he held to that view.

The CHAIRMAN. If your theory be true, is it not a sufficient reason for the force with which the water came, without reference to gas?

Mr. SKILLMAN. Yes; that would be so. Because as you go west through this James Valley, the Missouri River is higher than the valley. The bed of the Missouri River is at least 150 feet higher than the bed of the James Valley. I know of the survey that was made from La Moure, which is north of here, and the engineer who made that survey told me that he took the level of the sand of the Missouri River at Pierre, and it was over 150 feet higher than the James River Valley. But still that would not give us our source. The rule is, as I understand it, that for 15 pounds of pressure there would be a rise of $33\frac{1}{4}$ feet; with our wells, then, it would go to the top of the stand-pipe, something like 400 feet. That would be its natural feed.

The CHAIRMAN. That would be true but for the obstruction in the rock itself, which would take off some pressure.

Mr. SKILLMAN. Yes; of course the pressure would be less when you got towards the top. But if it comes from some source elsewhere the head would be higher.

The CHAIRMAN. But if it went a long distance, say 300 or 400 miles, would not the friction in passing through the sand retard the water so that if it did rise at all it would rise slowly?

Mr. SKILLMAN. Yes; unless there was a continuous body of water.

The CHAIRMAN. Have you ever seen experiments through a pipe of even-bodied water, and noticed what a long time it takes to get the water through, by reason of the friction? Take, for instance, a pipe 10 miles long and an inch wide; it would take a good while to get any water through that pipe.

Mr. SKILLMAN. Yes. I submitted to certain gentlemen connected with State institutions in Minnesota a question concerning our wells, and saying "Here is a pipe, say 1,000 feet long, and we have a certain amount of pressure given to the water," I asked the question, "What will be the daily flow or the flow per minute through that pipe?"

The CHAIRMAN. That is a pretty nice mathematical problem.

Mr. SKILLMAN. The answer I got was a difference of from six to nine million gallons per day.

The CHAIRMAN. That is, that you would discharge from six to nine million gallons per day through that pipe?

Mr. SKILLMAN. Yes. None of them put it lower than 6,000,000, and some of them put it as high as 9,000,000.

The CHAIRMAN. Describe the soil of this section.

Mr. SKILLMAN. There is first a loam of several feet, and then there is a subsoil of clay.

The CHAIRMAN. How is that as to holding water?

Mr. SKILLMAN. It is almost impervious to water. That is, the water will come until it strikes the subsoil, and then it comes very slowly. The subsoil does not let it up very quickly.

The CHAIRMAN. Suppose you have a ditch where there is a gentle incline, have you ever observed how it has dampened the soil on either side for a long distance?

Mr. SKILLMAN. Yes, I have; and when we put down our last city

well, last fall, before getting the flow of it properly arranged for, it ran over a farm adjacent to the town. The result is that the owner now has a crop of not less than 30 bushels to the acre, whereas, where the water did not touch the land, the crop is hardly worth cutting.

At Groton there was some defect in putting down the pipe, and the water ran all the time. It ran over one man's land, and he sued the city, but without regard to the suit the results of the overflow were that he has had very much better crops where the land was flooded than where it was not. There is no doubt that the water is abundant, and wherever there is seen to be an abundance of water the effect of it is seen on the trees and vegetation in the neighborhood. I think it is putting it mildly to say that it will more than double the productive function of the land. We have the soil here, and we have the sunshine, and all the rest would come if we had the water.

The CHAIRMAN. Would you regard as valuable to this community an examination of the country from here to the Rocky Mountains with a view of ascertaining the extent of this belt of water, and its source?

Mr. SKILLMAN. I would regard that as of very great value.

The CHAIRMAN. If it were ascertained that this supply came from a source that was inexhaustible and might be relied upon with certainty within given limitations, would that encourage the owners of the land to sink wells?

Mr. SKILLMAN. Yes; it would then give a fixed value to the land in this neighborhood. It would give a permanent value to all investments here. We know that the water is here, and if we have a fair assurance that the water will continue, at least during our lifetime, we know what the effect will be on the land and on the products of the land. My estimate is that whereas the land is now worth from \$8 to \$10 per acre, if the water beneath it could be utilized it would make a difference in the intrinsic value of the land to the extent of \$50 per acre, and I think that is stating it mildly.

The CHAIRMAN. The making of that investigation and ascertainment of the facts are within the functions permitted by Congress in the appropriations already made.

Mr. SKILLMAN. But it seems to me that wells might be put down experimentally for the purpose of ascertaining the localities and making certain that the water is to be continuous. I did not expect to make any statement before the committee with respect to this matter to-day, and I have therefore spoken wholly from memory. If there are any other matters upon which I can inform the committee I will be glad to do so in writing.

The CHAIRMAN. Can you state to us the cost of the wells at Aberdeen?

Mr. SKILLMAN. The cost of the first well was not far from \$4,000, the people not knowing just what they would have to go through or what precise amount of boring or piping was necessary at that time; now they have contracted for wells at about \$3,000 each.

The CHAIRMAN. If the business of digging wells were carried on largely, what would be about the probable cost?

Mr. SKILLMAN. From \$2,000 to \$2,500, and it would be done at a profit at that rate.

STATEMENT OF EDWARD STERLING, OF HURON, BEADLE COUNTY.

The CHAIRMAN. What is your occupation?

Mr. STERLING. I am farming.

The CHAIRMAN. Are you familiar with the farming lands of this locality?

Mr. STERLING. I am.

The CHAIRMAN. And their market value?

Mr. STERLING. I think I am.

The CHAIRMAN. What is the market value of improved lands outside of the immediate vicinity of towns?

Mr. STERLING. I should say \$5 or \$6 an acre, under the present condition of things.

The CHAIRMAN. What is the market value of unimproved lands in the same locality?

Mr. STERLING. There is but little difference between the unimproved and the improved.

The CHAIRMAN. What is the general character of the improvements?

Mr. STERLING. There are some very good improvements, but they are of all classes. When people first came here they were poor, and they have about held their own. They have not improved very extensively.

The CHAIRMAN. Have you seen any of the effects of irrigation on lands?

Mr. STERLING. I have not. Let me say to the committee that I raised, perhaps, about the first crops that were raised in this county. That was nine years ago. At that time we had a big snow-fall in the winter, and the lake beds were pretty full, so that they provided a sufficient moisture for the next two years. In those seasons our crops were magnificent. Everything that was put in the ground was a success. But from that time it has been gradually growing worse. There has been almost nothing produced, and values have decreased very much.

The CHAIRMAN. What would be the value of the same lands of which you have been speaking, provided you were sure of sufficient moisture each year?

Mr. STERLING. The change would be astonishing. I should say the difference would be from \$25 to \$50 an acre. Lands would sell readily here if we had sufficient moisture, and they would sell readily at that price.

The CHAIRMAN. Do you think it would make all that difference?

Mr. STERLING. I certainly do. At the opening out of this country, when we had sufficient moisture, everything grew luxuriantly, and the lands were sought for at \$10 an acre in their raw state. You could get \$1,500 or \$2,000 for a quarter-section. To-day they go begging at \$300 or \$400, simply for the want of moisture.

Adjourned.

NORTH DAKOTA DIVISION.

ON THE TRAIN AT JAMESTOWN, N. DAK.,
August 4, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF WARREN UPHAM, OF THE GEOLOGICAL SURVEY.

The CHAIRMAN. What is your occupation?

Mr. UPHAM. I am a geologist; at the present time an assistant of Major Powell, of the U. S. Geological Survey.

The CHAIRMAN. Where have you been operating?

Mr. UPHAM. The field especially assigned to me for observation, and of which I am to make a description and draft maps, is the valley of the Red River of the North, in Minnesota and Dakota. It is a great plain. It is the famous wheat region of northwestern Minnesota.

The CHAIRMAN. What is the geological formation of that valley?

Mr. UPHAM. It has a surface of lacustrine lake deposits, and beneath that a thickness of 150 feet on an average of drift.

The CHAIRMAN. What do you mean by that?

Mr. UPHAM. Glacial drift; ordinary glacial drift. The glacial drift is chiefly a stony clay, and is found after you get beneath the lacustrine lake deposits.

The CHAIRMAN. What are we to understand you to mean by lacustrine lake deposits?

Mr. UPHAM. The valley was occupied by a lake, and in it there were brought by tributary streams considerable deposits of fine silt and sand. That is to be found over a considerable part of this Red River flat.

The CHAIRMAN. Would that be called clay?

Mr. UPHAM. Yes, it is clay, although a fine sand. It is commonly called clay. It contains clay, but it is a fine sandy-clay silt. It is suitable for making bricks.

The CHAIRMAN. That is what you first find?

Mr. UPHAM. Yes; it is.

The CHAIRMAN. Underneath that you find what?

Mr. UPHAM. There is over the entire valley a silt of over 150 feet thickness on an average, and varying from 100 to 200 feet of glacial drift. It is a stony clay, different from the other in this, that it has gravel and sand in it.

The CHAIRMAN. What makes you come to that conclusion?

Mr. UPHAM. We see the material where it has been thrown out.

The CHAIRMAN. What do you find beneath that?

Mr. UPHAM. There is water in most of the wells, and coming in such quantities from the sand beds that the wells can proceed no farther. Accordingly we could not judge from that kind of observation what there is beneath.

The CHAIRMAN. Below this formation is there a stratum that is impervious to water.

Mr. UPHAM. Yes; the glacial drift, as I denominate it, is practically impervious to water. It holds the water down. The water that gets into the lower parts of the sand beds will be held down.

The CHAIRMAN. What is beneath this stony clay? What do they find immediately under it?

Mr. UPHAM. I think that the water is found in the gravel and sand beds pertaining to the glacial drift formation.

The CHAIRMAN. After you pass this stony clay, what do you then find?

Mr. UPHAM. Of most of the Red River Valley there is no knowledge deeper than the water-bearing bed of gravel.

The CHAIRMAN. Then you meet with sand and gravel?

Mr. UPHAM. There have been veins of it in the stony clay, and we may presume that there is stone and gravel at its base. Some of the artesian wells get their flow from the base of the glacial drift.

The CHAIRMAN. What do you mean by that?

Mr. UPHAM. The bottom, where there is no more glacial drift below, and then the wells come to the water-bearing beds of sand and gravel. Some wells go deeper, but that does not pertain to any artesian flow. The artesian flows in that valley are wholly from the drift and underlying sand river.

The CHAIRMAN. First you went through a formation which is commonly called sand, very fine sand, and some clay?

Mr. UPHAM. Sand, clay, and silt.

The CHAIRMAN. Then you come to clay with gravel in it, which clay and gravel is pretty hard and impervious to water, as I understand you?

Mr. UPHAM. And a good many pieces of stone; some large enough to be called boulders.

The CHAIRMAN. And below that you find sand?

Mr. UPHAM. Ordinarily; the artesian flows come from sand and gravel. They are obviously contained within the glacial drift. They are little veins or stream courses through sand and gravel.

The CHAIRMAN. You have not traced any one water-bearing formation of sand that can be identified over the country generally?

Mr. UPHAM. It can not be stated that the water-bearing stratum is a unit over this valley. We do not suppose it to be a unit. I remember the town of Grandin, which, the best my memory serves me, is in the Red River Valley, in Dakota. That town has four wells. These wells surprised me; and I know Hillsboro is a similar case. Taking Grandin, for example, and Hillsboro give us similar facts—these four wells, one 100 feet, one 50 feet, and two 250 feet, are within a radius of a quarter of a mile.

The CHAIRMAN. They have not found any general water-bearing strata through the country?

Mr. UPHAM. It is a water-bearing stratum in that case, but not so generally. This is exceptional. They seem there to be shallow streams—courses pinched out in places, the clay above and the clay beneath pinch them—and in places the sand and gravel bed is pinched; that is to say, reduced to nothing; the drill then goes through that and strikes some stream bed.

The CHAIRMAN. How prolific are they in furnishing water?

Mr. UPHAM. Their projection is small, in diameter about an inch. The stream is rarely 3 or 4 inches.

The CHAIRMAN. They are not used for irrigation purposes ?

Mr. UPHAM. They have never been used for that purpose. They are bored by the towns, and are used for domestic purposes. Such a well is serviceable to supply a small village, say, of 250 inhabitants, as Ada, in Minnesota. The people of that village get their drinking water from a single well. The stream is not larger than a pencil, and it flows out of the pipe and comes down in a curve very soon. Though it is very small, it supplies all the water in the town.

The CHAIRMAN. They do not use irrigation there ?

Mr. UPHAM. No; they have sufficient rain.

The CHAIRMAN. That matter has not been considered there ?

Mr. UPHAM. No; it is not a practical question.

The CHAIRMAN. You have moved forward here into a region where irrigation would be beneficial.

Mr. UPHAM. It would be beneficial for many years.

The CHAIRMAN. Have you ever been in a country where irrigation is practiced ?

Mr. UPHAM. I have not been in a country where irrigation is practiced. I have read of it.

The CHAIRMAN. You have not been farther west than Dakota ?

Mr. UPHAM. I have not been west of this mark. [Indicating on a map.] My work has been extensive in Minnesota.

The CHAIRMAN. I would like to ask if there is any practical purpose to which you could put your work ?

Mr. UPHAM. Is that a relevant question ?

The CHAIRMAN. Will you explain any practical good that will result from your investigation ?

Mr. UPHAM. I feel free to do that, but I do not consider it a legitimate part of your report.

The CHAIRMAN. I maintain that any one who is engaged in scientific investigations should show some practical benefit that will come from them.

Mr. UPHAM. I would gladly do so for your benefit, or for the benefit of anybody else who has an interest in them. But I do not think it should be legitimately incorporated in a printed report concerning this interview.

The CHAIRMAN. I wish to see what relations they bear to this world—the uses of man. And it is certainly legitimate to an inquiry in relation to irrigation, so far as that is connected with geology.

Mr. UPHAM. As a valid basis for Government appropriations, it is true some economic advantages ought to be shown. I think that is the only way we can place it before the tax-payer and ask him to assist in our researches.

The CHAIRMAN. That is the object of my inquiry.

Mr. UPHAM. Under that preliminary statement, and considering the U. S. Geological Survey in a very different manner from what I would ordinary geological investigations, I should say that these investigations will be the means of inducing immigration. If you were to ask me the use of geological investigations generally, I should say that they were of an educational advantage—an intellectual advantage to the people at large. But as a justification for the expenditure of public money, we must show some economic advantage. They are of great advantage to immigration. In all these new States it is considered of great advantage to bring in settlers; the people want neighbors; they wish to build up towns; and my work as a surveyor in this region is of great importance to induce immigration.

The CHAIRMAN. Of what advantage are your investigations to the State and the immigrants?

Mr. UPHAM. Having made these investigations we are able to set forth a truthful, a clear, a comprehensive, a full, and complete statement of the geographical and geological condition of the country, of the material resources and agricultural advantages of this whole district. In order to do this a full and complete investigation should be made. Unless there be a plain and truthful statement of the condition of the soil and the climate the right kind of settlers will not come.

The CHAIRMAN. There are not over the country where you have been examining any excavations or borings that gave you any idea of the formation under the ground?

Mr. UPHAM. The stream-courses and natural outcroppings of the rock in continuous districts enable us to determine the structure of what is underneath without boring underneath; and that is the case for a good part of the Red River Valley. Underlying a part of the Red River Valley of the North is Cambrian.

The CHAIRMAN. What kind of rock is that?

Mr. UPHAM. All sorts of rock formation are included in the Cambrian, as in the Oretaceous. We refer to the age of the rock when we use that term.

The CHAIRMAN. What kind of rock does it contain?

Mr. UPHAM. Limestone, sandstone, and all kinds of conglomerate and slate.

The CHAIRMAN. Does it contain granite?

Mr. UPHAM. No; granite is not contained there; it is a fossiliferous formation.

The CHAIRMAN. Take granite that has been by heat or by chemical action of some kind changed from its original condition, would that be found in the Cambrian?

Mr. UPHAM. No; I think not. Of course this is hardly relative to the case. Yet some geologists maintain that the Cambrian and all other rock formations down to the latest contain granite.

The CHAIRMAN. Do you regard geology as a science?

Mr. UPHAM. Certainly.

The CHAIRMAN. Have you any further facts or statements to offer?

Mr. UPHAM. I have some brief data I prepared in relation to artesian wells in the Dakotas, and as to the evidences also of periodic variations of rain-fall as shown by the levels of the lakes east of us, which I would like to present.

The CHAIRMAN. You may proceed.

Altitudes of lakes and rivers in North Dakota, determined by railway surveys.

	Feet above the sea.
Devil's Lake, August, 1887 (probably 1½ feet higher than now).....	1,431½
Devil's Lake, lowest and highest stages during the past ten years.....	1,430-1,434
Stump Lake, about 5 miles southwest of Devil's Lake, August, 1887.....	1,417
Red River of the North:	
At Wahpeton, low and high water.....	943-958
At Moorhead and Fargo.....	866-898
At Grand Forks.....	764-828
At St. Vincent and Pembina.....	748-788
At Winnipeg, Manitoba.....	723-763
Lake Winnipeg.....	710
Shyenne River:	
At bridge of the Jamestown and Northern Railroad, Shyenne.....	1,410
At Valley City.....	1,200
At Lisbon.....	1,064
At mouth, junction with the Red River.....	857

James River:

At New Rockford	1,502
At Jamestown	1,382
At La Moure	1,289
Lake Columbia, nearly 30 miles long	1,286
At Huron	1,228
At mouth, junction with the Missouri, extreme low and high water.	1,150-1,135

Missouri River:

At mouth of the Yellowstone, near Fort Buford and west boundary of North Dakota, low and high water, about	1,860-1,885
At mouth of the Little Missouri River, about	1,740
At Bismarck, extreme low and high water	1,618-1,646
At mouth of the Cheyenne River, about	1,460
At Pierre, South Dakota, low and high water	1,426-1,445
At Yankton, low and high water	1,157-1,198

Altitudes of track at railway stations in North Dakota.

	Feet.		Feet.		Feet.
Wahpeton	965	Cassellton.....	934	Dickinson	2,406
Fargo	905	Buffalo	1,202	Medora	2,267
Grand Forks	830	Tower City	1,172	Glendive, Mont....	2,069
Grafton	827	Valley City	1,220	Milnor	1,097
Neché	831	Spiritwood	1,479	La Moure	1,307
Larimore	1,134	Jamestown	1,408	Cooperstown	1,428
Devil's Lake	1,464	Eldridge	1,541	Carrington	1,584
Towner	1,479	Windsor	1,840	Fort Totten station ..	1,566
Minot	1,562	Steele	1,859	Minnewaukon	1,561
Bottineau	1,639	Bismarck	1,670	Sykeston	1,628

Mr. UPHAM. Hundreds of artesian wells 50 to 300 feet deep are obtained in the drift of the flat plain of the Red River Valley. Such wells can be had nearly everywhere within 10 to 20 miles from the river, both in Minnesota and North Dakota. South of Blanchard and Hillsborough they commonly supply fresh water, but northward it is almost invariably brackish, yet good for constant use to water cattle and horses.

Grafton artesian well, 915 feet deep; being drift, 298; Cambrian strata of limestone, sandstone, and shale, 605; Archean granite, 12 feet. The water, which is taken from a depth of 438 feet, is only slightly brackish, deeper flows being shut off because they were very saline. It flows (in August, 1887) through 6-inch pipe 40,000 barrels per day, or about 1,000 gallons per minute.

Devil's Lake artesian well, 1,511 feet deep, being drift, 25; cretaceous (Fort Pierre) shale, 1,403; very hard layer of gravel cemented by pyrite, 3 feet, and fine white or light sandstone, 80 feet. The water (brackish) rises from this sandstone, flowing through 3½-inch pipe 1,800 barrels per day. This well, in height above sea, depth bored, and section passed through is closely like the Jamestown well.

Tower City artesian well, 670 feet deep, being drift, 163; the Fort Pierre shale, 502, and sandstone supplying the water, 5 feet. This may be a sand bed within the Fort Pierre formation. The water flows at rate of 9½ gallons per minute, and when piped is capable of rising to a height of 33 feet above the surface.

Jamestown artesian well, 1,476 feet deep, being mainly the Fort Pierre shale, but reaching sandstone at bottom. Pressure of water at surface, 100 pounds per square inch; temperature, 70° Fahrenheit. I find no exact record of the section passed through by this well, and should be very glad to obtain it, if any one has preserved such record.

Aberdeen artesian well, South Dakota, 904 feet deep, being drift, 94, and the Fort Pierre shale, 810 feet, to sandstone at bottom, after passing through a very hard layer about 10 inches thick. Pressure, 140 to 160

pounds per square inch; temperature, 60°. The water, though saline, is pronounced very wholesome by physicians, and is much used for domestic purposes. It is drank by stock in preference to any other water.

The Grafton well takes its supply of water about 400 feet above the sea level. The wells of Devils Lake and Jamestown go slightly below the sea level; that of Tower City stops 500 feet above the sea, and the wells at Aberdeen, which are 1,300 feet above the sea, obtain their supply 400 feet higher than those of Jamestown and Devils Lake. All these wells, excepting that at Grafton, are in the Fort Pierre shale, which stretches from north to south across a broad belt of North Dakota west of the Red River valley. Within this belt, upon a width of a hundred miles or more, the conditions for obtaining artesian water are similar to those represented by the wells of Devils Lake, Jamestown and Aberdeen.

The stumps and fallen trunks of trees of a submerged forest in Stump Lake indicate that probably one hundred or two hundred years ago, or perhaps longer ago, it held for a long time a level several feet, at least 5 to 10 feet, lower than now. But a distinct shore line 15 feet above Devil's and Stump Lakes, below which shore line trees have not yet become established, proves that within a recent time, probably not more than forty or fifty years ago, these lakes held that higher stage. Within the past six years these lakes have fallen 4 or 5 feet. These recent fluctuations of the lake levels are dependent on increase and diminution of the average rain-fall.

Further evidence of periodic variations of rain-fall, a series of dry years being succeeded by others of plentiful rains, is supplied by the fluctuations in the levels of the great lakes tributary to the St. Lawrence. These lakes attained their highest stage, within our knowledge, since the coming of white men, in 1838; and they were nearly as high in 1814-'15 and 1788. Since 1838 they have reached maximum stages in 1847, 1858, 1870, and 1882. The lowest known stage of the great lakes was in the winter of 1819-'20, when Lake Erie was 6 feet lower than in 1838. In 1796 it was 5 feet lower than in 1838. Other years of low stage of the lake levels, mostly somewhat less remarkable, were in 1841, 1853, 1865, and 1875. These maximum and minimum stages of the great lakes have thus alternated in cycles of about a dozen years, in which comparatively scanty average rain-fall for several years was followed by unusually abundant rain-fall.

STATEMENT OF T. F. BRANCH, OF JAMESTOWN.

The CHAIRMAN. You are a surveyor and engineer?

Mr. BRANCH. Yes.

The CHAIRMAN. And have been engaged in your profession in this town for how long?

Mr. BRANCH. The last eight years.

The CHAIRMAN. Are you familiar with the artesian well that has been sunk here?

Mr. BRANCH. Yes.

The CHAIRMAN. Will you describe the material through which the drill passed in boring that well, and also the size of the well?

Mr. BRANCH. There are two wells here; one in town and one on the bluff west of here.

The CHAIRMAN. What is the depth of the well out of town?

Mr. BRANCH. Thirteen hundred and twenty-one feet.

The CHAIRMAN. Will you give the different kinds of material through which the drill passed?

Mr. BRANCH. There was 1 foot of soil that is black loam; 40 feet of clay subsoil; 49 feet of pure fire clay; quicksand with limestone boulders and pieces of lignite coal, 20 feet; shale and limestone gravel, 100 feet; light-colored shale, which slacks when exposed, with seams of soapstone running through it, 150 feet; shale, very dark in color, 200 feet; shale, in layers of dark and light colors, 400 feet; sand and slate formation, 40 feet; light-colored, rocky, rotten shale, 250 feet; iron, almost pure, 1 foot; water, of bad quality, 39 feet—

The CHAIRMAN. There was some other material beside water—not just clear water.

Mr. BRANCH. This was taken by the man who drilled the well. I suppose he struck a basin of water there. Black, rotten shale, 30 feet. That takes it to a depth of 1,321 feet, where it was abandoned. They got into the quicksand there and had trouble with their tools, etc.

Senator REAGAN. Where was that?

Mr. BRANCH. Out of town.

The CHAIRMAN. That well was abandoned?

Mr. BRANCH. Yes.

The CHAIRMAN. What is the depth of the one in town?

Mr. BRANCH. Fifteen hundred and seventy-six feet.

The CHAIRMAN. You have not the formations through which the drill passed there?

Mr. BRANCH. No.

Senator REAGAN. What is the difference in the altitude of the surface of the well in town and the one out?

Mr. BRANCH. One hundred feet.

The CHAIRMAN. The one at the asylum is 100 feet high?

Mr. BRANCH. Yes.

The CHAIRMAN. Have you any account of the sandstone formation in which the water was found?

Mr. BRANCH. No.

The CHAIRMAN. No description of that water. Have you any description of the kind of material the drill passed through immediately before they struck the water?

Mr. BRANCH. Sand, I believe.

The CHAIRMAN. Was there nothing hard over it—no capping over the sand?

Mr. BRANCH. Yes; sand-rock. The water was found in the sand.

The CHAIRMAN. Was there not a capping to the sand-rock—hard capping?

Mr. BRANCH. Yes.

The CHAIRMAN. Then they came to the sand-rock which contained the water?

Mr. BRANCH. Yes.

The CHAIRMAN. You do not know how deep they went into the sand-rock?

Mr. BRANCH. No.

The CHAIRMAN. What kind of water does this well furnish?

Mr. BRANCH. It flows 375 gallons per minute.

The CHAIRMAN. Has the water been allowed to run out in places to show the effect it would have in fertilizing the soil, nourishing vegetation?

Mr. BRANCH. Yes; I do not know whether it produces vegetation. It is used for household purposes.

The CHAIRMAN. Is it good water for that purpose?

Mr. BRANCH. Yes. It is drunk when it is cold; it is too warm to drink at first.

The CHAIRMAN. Of what temperature is it when it comes from the well?

Mr. BRANCH. Seventy-five.

The CHAIRMAN. Have you ever been in a country where they irrigate?

Mr. BRANCH. No.

The CHAIRMAN. So that the matter of irrigating, raising crops in that way, has never attracted your attention?

Mr. BRANCH. No.

The CHAIRMAN. Are you familiar with the Missouri River?

Mr. BRANCH. I have seen it; yes.

The CHAIRMAN. You have never examined it with a view to diverting it upon the land; taking it out of its bed?

Mr. BRANCH. No. I was in the Yellowstone Valley when they commenced their ditch.

The CHAIRMAN. In what part of the valley?

Mr. BRANCH. Billings. I was there laying out the town. The main thing we use the water for here is for protection against fire. We have 3 miles of pipe.

The CHAIRMAN. Would it not be an advantage to have irrigation here?

Mr. BRANCH. I think so.

The CHAIRMAN. Would it not be a good thing to have full crops each year? Would not the farmers be better off?

Mr. BRANCH. They certainly would.

The CHAIRMAN. Are you a judge of the price of land about here?

Mr. BRANCH. Yes.

The CHAIRMAN. You have surveyed land here?

Mr. BRANCH. Yes.

The CHAIRMAN. When you get away from the immediate effect of the city, in farming land, out 2 or 3 miles from the city what is it worth an acre?

Mr. BRANCH. Do you mean wild land?

The CHAIRMAN. Yes.

Mr. BRANCH. About \$2 an acre.

The CHAIRMAN. What are cultivated lands worth?

Mr. BRANCH. For cultivated land add \$3 or \$4 an acre.

The CHAIRMAN. That is, \$3 or \$4 more?

Mr. BRANCH. Yes.

The CHAIRMAN. That would make \$6 or \$7 an acre?

Mr. BRANCH. Yes.

The CHAIRMAN. What would the land be worth if it produced such crops as you had in 1881; that is to say, produced such crops every year?

Mr. BRANCH. It would be worth \$10 an acre.

The CHAIRMAN. Do you think \$6 an acre would be a fair average price for the land?

Mr. BRANCH. Yes.

The CHAIRMAN. The land is now worth \$7 an acre; if irrigated, \$10 more would be \$17 an acre. I think one of these wells would irrigate a township. Say it would irrigate half the township, 18,000 acres of land

That would be \$4 an acre. Eighteen thousand acres at \$4 an acre would be \$72,000 additional outlay. Would it not be a pretty good speculation to sink a well and divert it over the land in order to gain this \$72,000?

Mr. BRANCH. Wells do not cost more than \$5,000 or \$6,000.

The CHAIRMAN. And your ditches would cost \$5,000 or \$6,000 more, probably?

Mr. BRANCH. Yes. That at \$10,000 or \$12,000, would be a good speculation.

The CHAIRMAN. You could irrigate a half-township. If you could do it at all with this water, you could do it certainly with \$20,000. That would be making, on your basis, \$50,000. But I think the land would be worth a good deal more. I think the lands would be worth \$50 an acre here, pretty soon, if they produced such crops as you had in 1881.

Mr. BRANCH. I am taking the population as it is now. There are no buyers here now. When there are more buyers it will be worth more, of course.

The CHAIRMAN. Is not that what has checked emigration, the fact that you have these dry seasons here? If you could have such crops here as you had in 1881, every year, would there not be a rise in the emigration?

Mr. BRANCH. I think so; yes.

Senator REAGAN. Have there been other wells sunk in this region of country?

Mr. BRANCH. Not as far north as this, except at Devil's Lake.

Senator REAGAN. How far north is that?

Mr. BRANCH. About 100 miles.

Senator REAGAN. Do they get water there?

Mr. BRANCH. I do not know whether they struck water there or not.

Senator REAGAN. Do you know, Mr. Casey?

Mr. CASEY. Yes; they got water, and they had trouble by its choking up with sand.

The CHAIRMAN. I understand there is an abundance of water there?

Mr. CASEY. There is abundance of water, but not much culture. They did not get through the sand with the pipes.

Adjourned.

BISMARCK, N. DAK., August 5, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF R. M. STEVENS, OF LISBON, RANSOM COUNTY.

The CHAIRMAN. What can you tell the committee with regard to irrigation and the need of it in this part of the country?

Mr. STEVENS. I desire to say that I did not come here to give the committee any special information on the question of irrigation, but after having heard what you said of irrigation and its benefits, I prepared a rough draught of Ransom County, and would be prepared to furnish, if desired, a perfect map of the county, bearing upon the subject of which you spoke, which you may have to look over at your leisure.

I have resided in this Territory since 1882, and as a rule we have had sufficient rain-fall to insure us good crops. But this year, the first one in our history, the crops are almost a total failure. We have had a practical failure of crops in about 80,000 acres of land that can be irrigated for less money than any other land that I know of in Dakota. Ransome County is a county composed of twenty-four civil townships, being 24 by 36 miles square. The Cheyenne River, a river rising above in the mountains and running 500 miles to where it connects with the Red River of the North, runs through Ransom County. There are 63 miles of the river in the county. The average width of that valley on either side, taking the whole course, is about 2 miles, which would make 80,648 acres of valley land, all of which can, I think, be irrigated by water taken from the Cheyenne River.

The valley is particularly level in all its parts. There is no slough, nor is there any particular elevation in the valley. The bluffs on either side seem to run very regular throughout the whole county; and there are not, as you will find in the Missouri Valley, juts of hills running out into it, and then breaking away. You will find that it is very level all the way through. By a system of water-works, in the way that has been suggested by the chairman of this committee, a large amount of land can be irrigated from the Cheyenne River alone.

There is also in Ransom County a tract of land which runs across the county, and also through the counties of Sargent, Marshall, Day, and the counties south almost to Sioux City, Iowa, which seems at some time to have been the basin of the river. That tract in my county comprises 95,000 acres of land, which, if artesian wells were dug, could be irrigated without any trouble of ascent or descent in the irrigating system. It is practically a level system, running from north to south, and at a fall of about $1\frac{1}{2}$ feet to the mile.

The CHAIRMAN. Have you experimented at all with artesian wells there?

Mr. STEVENS. No; we have not any artesian wells in the county.

The CHAIRMAN. What is the nearest artesian well to your place?

Mr. STEVENS. The nearest to us is at Pierre City.

The CHAIRMAN. Are there any small streams, lagoons, or ravines running into the mountains or higher lands, from that county?

Mr. STEVENS. No; it is a perfect valley, as if it had been the bed of a river.

The CHAIRMAN. Are there not places where you could make reservoirs?

Mr. STEVENS. There are places where artificial reservoirs could be made; none others; at least not in this tract. There are on either side of this tract hills, with what in this country we call "coulees." It is simply a break between two hills, where the water finds its way. By stoppage of those, artificial reservoirs could be made down that tract of level land.

The CHAIRMAN. And in case the artesian wells should fail you might store water in the wet seasons to help you out in the summer.

Mr. STEVENS. To be candid with you, and tell the actual facts as they exist, I don't believe that enough water could be collected in that way from reservoirs that could be made in these coulees to be of any practical account. There might, however, be reservoirs made that would store artesian waters in that way. They would make good store-houses. But, so far as the natural fall of water is concerned, I don't believe these places are of sufficient size to accumulate water so as to be of practical benefit in that way.

The CHAIRMAN. Has there been any examination made to see what basins there were in your region?

Mr. STEVENS. No. I am very familiar with the entire area of land in our county, so far as an individual may be familiar with it who has no particular views upon irrigation. But although I have never looked at the land with regard to the question of irrigation, I know that if I were to go back now and look at it with that subject in view, I should be able to make my statements here more to the point. There are places on either side of the Cheyenne River which could be utilized for the storage of water without any material injury to the land around it.

The CHAIRMAN. How much water flows into the Cheyenne River?

Mr. STEVENS. I don't know.

The CHAIRMAN. How much at any one time?

Mr. STEVENS. The river on an average is about 60 to 80 feet wide, and is on an average from 6 to 12 feet deep. At this time of year the river is very low. There are places where people can run across it dry shod without having to jump more than a few feet. But in the spring-time the water coming down from the mountains, where it melts, always gives us a head of 18 to 20 feet on an average throughout our county. And I think the same will hold true through Barnes and other counties through which it passes.

The Cheyenne River also passes through Cass County and runs about 30 miles, with its angles, to the Red River Valley, entering into Red River near the railroad bridge where the train crosses coming from Fargo to Bismarck.

The CHAIRMAN. There would be no difficulty in making reservoirs on the branches of that river to increase its capacity, if there was not enough there?

Mr. STEVENS. None through our county.

The CHAIRMAN. How would it be above that?

Mr. STEVENS. I am not familiar enough with the topography of the country above to answer that.

The CHAIRMAN (to Major Powell). Do you wish, Major, to ask this gentleman about his part of the country?

Major POWELL. No; I know very well the country he speaks of. What he calls "coulées" are very well adapted for the storage of the storm waters. But you remember you need only a little water there. It is only an occasional season that water is needed so far east as that. And it is easy to store water in the lateral valleys in that stretch of country.

Mr. STEVENS. I think so.

Major POWELL. Every two or three seasons there will be a dry year, when you will need two or three inches of rain more than comes from the heavens.

Mr. STEVENS. I ought to add that the valley of the Cheyenne River comprises 80,640 acres, or approximately that. It has been the most productive soil of which we have any knowledge in this Territory while I have been in it, and is exactly the same kind of soil as that of the Red River Valley. This year, for the first time, the drought has taken every bit of the crops in our valley.

STATEMENT OF N. G. ORDWAY, OF BISMARCK.

The CHAIRMAN. The committee would like you to make such statement as you would desire with reference to the condition of this Territory in regard to irrigation.

Mr. ORDWAY. I came to this Territory in June, 1880, and assumed office as governor. I immediately passed up the Missouri River to Fort Sully, and crossing the Big Sioux reservation in the summer of 1880, passed up and down the streams and coulees in the Black Hills. After spending some time in examining the resources of the Black Hills, I came out across the country to this place, Bismarck. I have traversed that portion of the Territory between this point and Yankton three or four times since 1880. Also in 1880, 1881, 1882, and 1883 I visited the Red River Valley of the North. I have also passed through the Territory by wagon teams nearly all the way from Yankton to Totten, and have seen nearly all of the principal towns in the Territory grow up. I became strongly impressed in my first trip through the Territory with the idea that water could be stored, and that in most cases it could be accomplished in these soda and salt beds that we have, or lake beds, I suppose you might call them.

The CHAIRMAN. Are they of sufficient altitude to let the water upon the surrounding country?

Mr. ORDWAY. Those dry lakes have held the water evidently a great many times, and they hold water now except in very dry seasons. It occurred to me that by the proper arrangement of their banks these natural lake beds could be very easily used as storage places for water, and that in addition to the water we would amalgamate and mingle the productive properties of those beds and have them for fertilizers onto the land. The alkali beds, as I understand it, are susceptible of the same productive uses as the ashes and the silt that we purchase in the East in large quantities to put on our eastern land; and it seemed to me that nature had compensated for the defects, you might say, of the soil in some places here, by leaving those beds in a condition to be utilized as fertilizers.

The CHAIRMAN. Do you allude to any particular locality where these beds exist?

Mr. ORDWAY. They exist all over what might be called the arid portion or dry portion of the country. In the Red River Valley of the North, extending from Fargo north, the soil is of such depth and richness that there are very few of those beds. But all along the James River and all along the North Pacific line on both sides, after you leave Jamestown and until you strike the Montana line, you will find these beds almost all along and contiguous enough, in my judgment, to be useful for the purposes indicated.

The CHAIRMAN. Have they all outlets so that they would run down low before evaporation exhausted them?

Mr. ORDWAY. This year they are not all run down. They had more rain-falls in this belt this year than they had for three years previously. This year, all along the Missouri to this point, we have had very little rain-fall; but late in the spring season we have had rains quite abundantly, and some of these beds have water in them.

The CHAIRMAN. When there is water in these lake beds is it very much impregnated with alkali?

Mr. ORDWAY. Yes; very strongly.

The CHAIRMAN. Sufficiently strong to kill vegetation?

Mr. ORDDWAY. Yes; when they are very low. My idea would be that those beds would have to be raised and a sufficient volume of water accumulated so that it would be in the right condition to use and drain upon the soil. And in many places, it seems to me, even in the flood times of the Missouri in this direction, that gates might be so arranged that there could be held there much of the water which recedes. We have what we call the June rise. You know what that is. This year we had a pretty heavy rise.

Director POWELL. In how much of this space do you think irrigation is necessary?

Mr. ORDDWAY. A large portion of North Dakota and of South Dakota, bordering on the Missouri and James Rivers, until you reach Bon Homme County and the lower counties of South Dakota, ought to have water storage in order to be sure of the crops. But I do not think water storage in the Red River of the North is absolutely necessary.

Director POWELL. How many crops have you raised in eight years?

Mr. ORDDWAY. In 1880 they had a good crop here. They have cut on a stock farm here within a short distance of this town as good wheat as I ever saw; and all through here to Fargo and to Minnesota, and up the Red River, it was a splendid crop. But I do not think there has been since that more than one crop in three, on an average, in the James Valley or the Missouri Valley. I do not think the Red River Valley has ever had what you might call a real failure, except partially last year; the early frosts produced great damage in the Red River counties.

Director POWELL. On the eastern portion of the Territory, in the eight years that you have been here, how many bad years have they had?

Mr. ORDDWAY. In the eastern portion not more than two have been what you would call bad years. You can not expect big crops every year. But the yield of wheat has been from 10 to 30 bushels to the acre. In Walsh County, where I have a ranch, north of Fargo, and in Cass County, the third county north, they marketed two years ago 6,000,000 bushels of wheat, which produced a cash revenue of \$4,000,000. That was the largest crop that they have ever had, and I think that Pembina and Grand Forks, to the north of Cass County, with other counties in the Red River Valley, did nearly proportionately as well in that respect.

Director POWELL. How much timber have you in Dakota?

Mr. ORDDWAY. There is quite a large amount of timber on the Red River and the rivers that start from the Turtle Mountains at the foot, and run into it.

Director POWELL. That is the western portion?

Mr. ORDDWAY. Northwestern portion. There are belts of timber on Souris or Mouse River, a half mile wide on each side, tall oaks standing, and on Park River and other rivers that find their source in the north; and we have an abundance of timber all through that portion of Dakota. Perhaps we do not appreciate that so much here, as we have coal in abundance—not right here, but across the river 40 miles. We have an abundance of coal that extends across the river into this county. In McLean County they have coal beds, and it can be put on the cars for \$1.25 a ton.

Senator REAGAN. What counties are those?

Mr. ORDDWAY. The county across the river is Morton County, and the one just across here on this side of the river is McLean County. I think there is some in Burleigh County, and some in Stark County. Stark County is further north still. It is on the new line of road

that parallels the North Pacific to Montana—Mr. Hill's road, the Manitoba road. There is a road extending from Grand Forks to Stark County, and in that county there are very fine deposits on that line.

I want to say one word about wells in the Red River Valley. At Grafton and other points you can get flowing wells at about 400 feet. It is the shortest distance I have seen them at any place in the Territory. In Grafton there is a very fine flowing well that they use for fire purposes, and they are about to make a park with a lake in it. That well flows in such abundance that there will be water enough to water the whole country. It even runs down the streets on each side. I have examined these wells, and I find that 400 feet is all that is necessary in that portion of the Territory. In almost every portion of North Dakota I think you will find that from 400 to 1,800 feet you will be sure of getting water. I think that all this western portion of North Dakota deserves your special attention, and that it will become a very fruitful country.

Senator REAGAN. Do you know whether the water in the well at Grafton was found in a porous sandstone?

Mr. ORDWAY. Yes; it was. It was found there, and I have specimens of it, but not with me now. It was that porous sand-rock, and it comes in great abundance from the mountains.

The CHAIRMAN. What is the depth of that well?

Mr. ORDWAY. Four hundred feet. Individuals are having them sunk for use in their houses. These are in addition to the one used for city purposes and fire purposes and the lake. They only cost \$2 a foot.

The CHAIRMAN. Does the increase in the number of the wells perceptibly affect the flow?

Mr. ORDWAY. Not in the slightest respect.

The CHAIRMAN. What is the cap-rock that is immediately over the water?

Mr. ORDWAY. It is a pretty hard, blueish stone—a little blue. I do not know what you would call it.

The CHAIRMAN. Clay-slate, probably.

Mr. ORDWAY. Clay-slate I should say. I had a piece of it given to me the other day. I was out there the other day. The mayor of the city was laying out the park with a beautiful lake bed, and the water is all coming from this well which they have for fire purposes. They discard their engines and when they have a fire they just turn the water on and drown it out.

STATEMENT OF B. F. SPALDING, OF FARGO, CASS COUNTY.

The CHAIRMAN. How long have you resided in Fargo?

Mr. SPALDING. Nearly ten years.

The CHAIRMAN. What can you say as to the production of crops, whether the drought has interfered with them during the ten years that you have lived there?

Mr. SPALDING. There never has been a period of complete failure of crops from lack of rain-fall; but crops have been diminished by insufficiency of rain-fall. There has been no failure during that time. Last year we came the nearest to a failure; but that was owing to frost. But this season we will not have more than one-half or two-thirds of an average crop.

The CHAIRMAN. Have you considered all the benefits that might arise by using irrigation during the dry season?

Mr. SPALDING. I have not. Regarding the necessity of irrigation, I would extend Governor Ordway's limits a little farther east. I would say that, in my judgment, west of the western border of Cass County they can not get more than an average of one crop in two, if they can do that.

The CHAIRMAN. How far is that from the Red River?

Mr. SPALDING. Forty-three miles.

The CHAIRMAN. Outside of that strip of 43 miles along the Red River you would require irrigation to get regular crops?

Mr. SPALDING. I think so. And regarding wells, I would say that they have bored for them unsuccessfully in different parts of our county, while in other parts they find small streams. At Tower City, on the western border of our county, they have quite a large well, and also in Mayville, which is in Traill County.

The CHAIRMAN. To what depth did they go at Tower City?

Mr. SPALDING. Nine hundred and some feet.

The CHAIRMAN. What was the character of the water?

Mr. SPALDING. It was one of the first wells in the country where they found water, and I can not tell you.

The CHAIRMAN. You do not know what the substance was in which they found the water?

Mr. SPALDING. I do not. I have not thought of the matter for a long time; and in Mayville, which is in Traill County, a short distance north of Cass, they have a very powerful well.

The CHAIRMAN. What is the depth of that well?

Mr. SPALDING. My impression is that it is the same depth as the one at Tower City. At Morehead, in Minnesota, just across from Fargo, they are boring a well, and have reached 1,300 or 1,400 feet without success.

The CHAIRMAN. Do you know what material they have gone through there? Have they kept a record of it?

Mr. SPALDING. They have kept a record of it; and they have mostly gone through granite. They sent that to a geologist of Wisconsin.

The CHAIRMAN. What did he say it was?

Mr. SPALDING. That they would not strike any water.

The CHAIRMAN. What depth did they strike that formation?

Mr. SPALDING. Something like 1,200 feet.

The CHAIRMAN. Did the geologist say it was granite?

Mr. SPALDING. I do not know whether they sent a sample. They told him it was granite.

The CHAIRMAN. They might have made a mistake.

Mr. SPALDING. I have no knowledge on the subject.

STATEMENT OF W. E. PURCELL, OF WAHPETON, RICHLAND COUNTY.

The CHAIRMAN. In which direction is your county from here?

Mr. PURCELL. It is a southeast county of Dakota, on Red River, right at its source.

The CHAIRMAN. Have you ever been without sufficient rain-fall for crops?

Mr. PURCELL. Yes. We have had in our county at least two failures, what you might call failures, in ten years. Last year we did not have more than half the crop. But, as stated by Mr. Spalding, it was in consequence of frost in the early part of the season, along in the month of May, after the wheat had been sowed, after it had grown 4 inches.

This year our county will yield as large, perhaps, as any county in the Territory. But it is only in spots. In some portions of our county, which have heretofore yielded the best, this year's yield was virtually nothing. In the early spring, after the wheat had been sown three or four weeks and it looked nice, we had some terrific wind-storms, and in the portions of our county where the storm was heaviest it seemed to do the most damage. Along what we call the sand-hills in our county we have had the best crops. Most of the crops were covered by sand. A man driving along the field would see virtually nothing, yet they have the best crops there.

The CHAIRMAN. How do you account for that?

Mr. PURCELL. It is singular with us this year. Along the Red River and along the Wild Rice River, in the northern part of our county, where there has been as much rain as we have had in the south, the crops were nearly a total failure. And that is right up to the river.

The farmers in that locality say they have the same wheat and the same seed, that they have tilled equally well as in former years, and that they have had nearly as much rain-fall and yet the crop is scant. The rains this year in our county have not followed the river—we use a common expression, usually, "follow the river"—but they have left the rivers and gone into the country. For instance, 6 miles west of the Red River the Wild Rice River runs north, and they have had good crops in that region and adjacent thereto. But in what we consider the sand region this year we have the best crops. They have as much rain-fall as we have right along the river. We consider the best farms are along the river. But this year they are not as good, and they pay the same attention to the seed. I think we have only three flowing wells in our county.

The CHAIRMAN. Has the land back of the river been tilled as much as the other?

Mr. PURCELL. No. It has not been tilled more than four or five years, while the land adjacent has been tilled more.

The CHAIRMAN. That may have something to do with it.

Mr. PURCELL. That may have something to do with it. But the query with me was, in listening to the discussion of irrigation, what plan would be adopted to hold the water in a country as flat as is Richland County.

There is probably not more than an average of 3 feet fall in the bottom of the Red River for a distance of 8 miles west of the river. The land is level and flat. What plan could we adopt in that county for holding the water?

The CHAIRMAN. Is there any difficulty in taking the water out of the river if you need it?

Mr. PURCELL. No; the current is very strong.

The CHAIRMAN. And the banks low?

Mr. PURCELL. Yes.

The CHAIRMAN. There would be no difficulty in turning the river.

Mr. PURCELL. No. But how? By constructing artificial reservoirs?

The CHAIRMAN. By turning the stream. That is the first thing to do.

Mr. PURCELL. By diverting the stream?

The CHAIRMAN. Yes; if you have a country of that kind, a good flow in the river and very level off from it, it would be very little trouble to divert the water. When you have enough water in the river, make reservoirs; where you can not get out the stream. Where you can have artesian water, let that be the system. You will have to use your best judgment. The object to be accomplished is to get the water on the land.

STATEMENT OF ELIJAH BOLEY, OF BURLEIGH COUNTY.

The CHAIRMAN. How long have you resided in Burleigh County?

Mr. BOLEY. Twelve years.

The CHAIRMAN. How many years have you had good crops out of the twelve?

Mr. BOLEY. About six, I think, that we have considered good crops since I have been there; 1877, 1878, 1879, and 1880 were good crops; 1882, 1884, and 1885 were good crops.

The CHAIRMAN. How has it been since 1885?

Mr. BOLEY. Pretty hard since 1885.

The CHAIRMAN. On account of the drought?

Mr. BOLEY. Yes.

The CHAIRMAN. Have you in your section considered the question of irrigation?

Mr. BOLEY. We have been thinking about it considerably, but it is quite lately. We have been expecting better seasons right along since 1885; 1885 was a very good season.

The CHAIRMAN. What have you to say about artesian wells?

Mr. BOLEY. I know but little about them. I came here more for information about wells than anything else. We think we might have wells on those high lands; we think they would be of great advantage to us; we are on pretty high land.

The CHAIRMAN. In what part of the State is your home?

Mr. BOLEY. Right across the river in Burleigh County, at Mandan. The second bench across the river is quite narrow.

Director POWELL. What is the name of the stream near you?

Mr. BOLEY. Square Buttes.

Director POWELL. What is the one to the south?

Mr. BOLEY. Hart River comes in south of us; Little Hart and Big Hart and Cannon Ball.

Director POWELL. Your farm is right on the top of the ridge?

Mr. BOLEY. Yes.

Director POWELL. You have not cultivated the low land?

Mr. BOLEY. I am not on what they call the low land or second bench. Really, the first of those bottoms they call the first, and then I am on the bench above that.

Director POWELL. I want to get at this idea. If I remember rightly, your farming country there is all on top of the ridge, is it not?

Mr. BOLEY. Yes.

Director POWELL. And they have not attempted anywhere to cultivate the valley lands of Heart River?

Mr. BOLEY. I think they have what they call the valley. I think there is some of that cultivated. That is what we call the flat lands. There is nobody cultivating those that I know of.

The CHAIRMAN. You have not tried wells in that direction?

Mr. BOLEY. No. I have not dug wells over 30 feet deep. I have dug some of those 32 feet deep and 24 feet deep. We are right there close to the river, and from 20 to 30 feet we will get water. We are inclined to think it is on account of seepage from the river. We have not struck any veins of water; it seems to sink in all around.

STATEMENT OF GEORGE PEOPLES, OF MANDAN, BURLEIGH COUNTY.

The CHAIRMAN. You are a coal miner?

Mr. PEOPLES. I work at almost everything.

The CHAIRMAN. Do you know anything about the crops, whether they have been affected in your vicinity?

Mr. PEOPLES. Well, I think they are affected greatly by drought. If we had rains and the ground was dampened, we would have good crops.

The CHAIRMAN. Have you considered any mode of watering the land?

Mr. PEOPLES. I think there is a good chance of irrigating all the land west of the Red River.

The CHAIRMAN. What kind of a chance?

Mr. PEOPLES. By irrigating from the Cannon Ball and the two Heart Rivers.

The CHAIRMAN. Do they run water in the spring?

Mr. PEOPLES. Yes; there is always water in them. They are springy at the head.

The CHAIRMAN. Then you have a very easy problem before you?

Mr. PEOPLES. Yes; if we had the means to settle it.

The CHAIRMAN. Are you getting out coal at Mandan?

Mr. PEOPLES. Twenty-three miles from Mandan.

The CHAIRMAN. Have you a good vein?

Mr. PEOPLES. From three feet and a half to seven feet.

The CHAIRMAN. What kind of coal?

Mr. PEOPLES. Lignite.

The CHAIRMAN. Does it burn up?

Mr. PEOPLES. It makes a good fire.

The CHAIRMAN. What kind of ashes does it leave?

Mr. PEOPLES. White ashes; no clinkers.

STATEMENT OF T. S. UNDERHILL, OF STARK COUNTY.

The CHAIRMAN. Where is Stark County?

Mr. UNDERHILL. It is next west from here.

The CHAIRMAN. Commencing where from Bismarck?

Mr. UNDERHILL. Seventy-five to 80 miles west.

The CHAIRMAN. Will you describe that county?

Mr. UNDERHILL. It takes in the headwaters of these streams—the Heart on the south and the Knife on the north.

The CHAIRMAN. Do they furnish much water.

Mr. UNDERHILL. Constant streams of water. Stark County embraces the headwaters of the Knife. About the center of the county, along which the railroad runs, is the divide between the north and south. Two miles from the railroad is a number of streams.

The CHAIRMAN. Is there any difficulty in diverting that water and putting it upon the land?

Mr. UNDERHILL. To a limited extent I think not. These streams are moderate during the dry season and waste away before reaching the river.

The CHAIRMAN. Could not the water be stored in reservoirs in the dry season.

Mr. UNDERHILL. After talking to Major Powell I think it is practicable to make reservoirs of those basins and lakes. But the water

could not be available for a large area of country, because we are in so many ranges, and ridges, and divides, and our river bottoms are limited in extent.

The CHAIRMAN. When you have learned the great benefit of irrigation you will find a good many places where you can store water.

Mr. UNDERHILL. And hold it. In this soil where springs leak away, would not a large body of water follow that and sink deep into the ground?

The CHAIRMAN. If you make the reservoirs to sink, yes. But if you make the reservoirs up on one side where there is no subterranean channels it would not. You would not want to build a reservoir over a channel where it would soak out.

STATEMENT OF A. O. WHIPPLE, DEVIL'S LAKE CITY.

The CHAIRMAN. Where is Devil's Lake City?

Mr. WHIPPLE. It is on the north shore of the lake.

The CHAIRMAN. In what part of the State is that?

Mr. WHIPPLE. About 90 miles east of Grand Forks, on the Manitoba road leading to Helena.

The CHAIRMAN. What is the condition of your country; does it require irrigation?

Mr. WHIPPLE. I should think it did. This year we have lost all our crops. I do not know where we are going to get water.

The CHAIRMAN. What are the facilities for getting water?

Mr. WHIPPLE. I do not know; perhaps on the west, coming out of the mountains in the spring.

The CHAIRMAN. Have you ever considered the feasibility of storing water in the ponds?

Mr. WHIPPLE. No.

The CHAIRMAN. You have water-sheds?

Mr. WHIPPLE. I suppose we have; but Devil's Lake has no inlet or outlet.

The CHAIRMAN. How deep is that lake?

Mr. WHIPPLE. Under the bluffs it is quite deep.

The CHAIRMAN. How much area does it cover?

Mr. WHIPPLE. Fifty-five miles by 15 miles.

The CHAIRMAN. And is it so low that you could not get an outlet?

Mr. WHIPPLE. No; we would not have any trouble about an outlet; several years ago there was an outlet into the Red River, where it enters into Fargo.

The CHAIRMAN. Why do you not secure an outlet?

Mr. WHIPPLE. We do not wish to do it; we want that lake there; there has been no overflow of that lake for the last fifteen or twenty years.

The CHAIRMAN. If an outlet were cut you could then draw the water off in dry seasons for irrigation; you could have a dam to stop up the outlet and let the lake fill again.

Mr. WHIPPLE. The last year that lake has receded; it is 28 feet lower on its shores than it was 22 years ago.

The CHAIRMAN. And it will continue on until you have rainy seasons?

Mr. WHIPPLE. Yes.

The CHAIRMAN. Then it will fill again?

Mr. WHIPPLE. I hope so.

The CHAIRMAN. That stream has too much salt in it for irrigation?

Mr. WHIPPLE. If you regard it so. It tastes like that German bitter water, if you are familiar with that.

The CHAIRMAN. You can not irrigate with salt water because it kills vegetation.

Mr. WHIPPLE. There are streams coming out of the mountains that could be made available. There are natural coulees that flow into this lake, and in 1883 those were large lakes, so that steam-boats could run up 20 or 30 miles. Now they are dry.

The CHAIRMAN. If an engineer familiar with the turning of water and storing water could make an examination and point out how to irrigate, do you think your people would undertake it? I mean, of course, if the plans were feasible.

Mr. WHIPPLE. I do not know that they would. We have had an engineer to examine the altitude of the lake out of town for the purpose of giving us some water, and he did not find the flow sufficient. That is a fresh-water lake.

The CHAIRMAN. How much of a fresh-water lake have you?

Mr. WHIPPLE. It is 6 miles long and a mile or two wide.

The CHAIRMAN. Has that an outlet?

Mr. WHIPPLE. It has an outlet when it overflows, running into the bed of a coulée and from there into Devil's Lake.

The CHAIRMAN. Do you not think there could be some plan devised for getting the water of Devil's Lake and the other lake onto the land?

Mr. WHIPPLE. We have not water enough. We have no water in the spring. It was lower in the spring than in the fall. We have had no difficulty in our section except this year.

STATEMENT OF V. B. NOBLE, OF BOTTENEAU COUNTY.

The CHAIRMAN. Is irrigation required in your county?

Mr. NOBLE. It is this year.

The CHAIRMAN. It never has been before?

Mr. NOBLE. Never before, since I have been there.

The CHAIRMAN. How long have you been there?

Mr. NOBLE. Since 1880. And settlers who have been there since 1883 say there has been no necessity for irrigation except this year.

The CHAIRMAN. Botteneau County is at about the one hundredth meridian?

Mr. NOBLE. The hundredth meridian of west longitude.

The CHAIRMAN. You have several lakes there?

Mr. NOBLE. They are in the Turtle Mountains; and those lakes might be used for irrigating purposes; they are from 400 to 800 feet higher than the main land.

The CHAIRMAN. They would make splendid reservoirs. Is there a large number of those lakes?

Mr. NOBLE. Yes; quite a number of them.

The CHAIRMAN. What extent of agricultural lands are below those lakes, and what extent could it be irrigated if they were used for reservoirs?

Mr. NOBLE. Do you mean the area they could reach?

The CHAIRMAN. Yes.

Mr. NOBLE. The area they could reach would exhaust the lake. The mountains rise up from the prairie virtually from about 50 miles long and 25 miles wide, in an oval shape and all the country around south of them. Of course, they are right on the boundary line; part of them

on the Canadian side, and the land on this side is prairie land, much lower than the mountains.

The CHAIRMAN. Do you not think you have described a district where irrigation is quite easy, if you want it?

Mr. NOBLE. Why, certainly; I think that country could be irrigated from the mountain quite easily. Of course the mountain streams for the past five years have been drying up very rapidly. Places where there were large lakes are now quite dry.

The CHAIRMAN. You expect them to remain dry until the seasons have changed, and then you expect them to fill again. They have been doing that always heretofore.

Mr. NOBLE. They have been doing that always. As soon as we get a good snow-fall or rain-fall they will fill again.

STATEMENT OF E. M. PAULSON, OF MAYVILLE, TRAIL COUNTY.

The CHAIRMAN. How much water does the well at your place discharge?

Mr. PAULSON. They claim that it is from four to five thousand barrels in the twenty-four hours.

The CHAIRMAN. How far will it spurt up?

Mr. PAULSON. Twenty-two feet.

The CHAIRMAN. Of what depth is the well?

Mr. PAULSON. Three hundred and fifty-five feet nine inches.

STATEMENT OF W. H. ROWE, OF DICKEY COUNTY.

The CHAIRMAN. In what part of the State is Dickey County?

Mr. ROWE. The southern part. It lies almost immediately south of Jamestown.

The CHAIRMAN. On the James River?

Mr. ROWE. The James River flows through the eastern portion of it.

The CHAIRMAN. How does the drought affect that section of the country?

Mr. ROWE. In the southern portion we were affected very seriously this year.

The CHAIRMAN. How long have you lived there?

Mr. ROWE. Since 1882.

The CHAIRMAN. How long have you been affected by the drought? How long has it been since you have had poor crops?

Mr. ROWE. I will state it this way: In 1882, 1885, and 1888 we had sufficient rain-fall for crops, and droughts the other years.

The CHAIRMAN. Have you ever considered the question of irrigation in your county?

Mr. ROWE. We have so much so that we have a local organization in the county to consider the subject.

The CHAIRMAN. Have you thought of the feasibility of artesian wells?

Mr. ROWE. At Ellendale they have an artesian well.

The CHAIRMAN. To what depth did you go for that well?

Mr. ROWE. Somewhere in the vicinity of 1,000 feet.

The CHAIRMAN. Through what material did you go immediately before you struck the water?

Mr. ROWE. I think a hard surface, shale, and then the water was found in sand or gravel.

The CHAIRMAN. White sandstone?

Mr. ROWE, Yes, sir; I think white sand.

The CHAIRMAN. How deep did you go into that sand?

Mr. ROWE. I could not say. The well has a pressure of 125 pounds to the square inch.

The CHAIRMAN. What is the size of the well?

Mr. ROWE. It is a 4-inch bore.

The CHAIRMAN. It furnishes considerable water?

Mr. ROWE. Yes; quite a volume.

The CHAIRMAN. Are there any streams that could be turned in your county?

Mr. ROWE. I will state that in the Western portion of the county, the western interior townships, in what we call the coteaux, rising from those hills are various little branches of what is called the Elm, the North and South Branches of the Elm and Maple rivers. They flow east to the center of the county and there turn off into South Dakota. The channels of those branches usually, when flowing, are quite deep, and in the other places right along from those hills the water could be stored. I do not know any other way that the water could be stored.

The CHAIRMAN. Reservoirs could be formed there?

Mr. ROWE. Yes. But this Little Maple River, after leaving the hills 5 or 6 miles, commences to form pools. It is not flowing this year.

The CHAIRMAN. You might enlarge those pools by dams and then take the water out.

Mr. ROWE. This little river could be readily dammed and made to retain the water in the spring, but it could not be raised over the bluffs onto the table-lands.

Mr. WHIPPLE, (of Ramsey County). I wish to call attention to an artesian well in our town. We got down 1,500 feet and came to sand; in fact, went into sand a long distance, perhaps 50 feet.

The CHAIRMAN. What kind of sand was it?

Mr. WHIPPLE. As white as that marble. [Indicating the top of a center table.]

The CHAIRMAN. What did your drill go through before it came to the sand?

Mr. WHIPPLE. I do not know. When we got to the sand, when the well was from 180 to 200 feet deep, we had good water; afterward the sand commenced to choke up the pipe, when it was suggested by the men sinking the well that we put down a 4 inch pipe, the other being a 3-inch pipe; we have a flow of water now that resembles milk, with a pressure of about 70 pounds to the inch; it does not amount to much, and is growing less and less because of the sand that is filling it up. They commenced the construction of that well about October or last of September, and they worked all winter to get rid of the sand; the sand is beautiful when the water is dried out of it; the result is our well is a failure after costing \$12,000.

The CHAIRMAN. You say you got a stronger flow below the sand?

Mr. WHIPPLE. Yes; at 200 feet the sand came up in the pipe; it took a week to get it out. The suggestion of an inside pipe came through an expert from Chicago, but it was of no assistance and it was taken out. The cost of the pipe was as much as the boring of the well.

The CHAIRMAN. You did not try putting down a perforated pipe?

Mr. WHIPPLE. No.

The CHAIRMAN. You have not tried the experiment of putting down a pipe prepared for that purpose?

Mr. WHIPPLE. No. We took out the inside pipe.

STATEMENT OF J. J. LUCK, OF NEW SALEM, MORTON COUNTY.

The CHAIRMAN. What information can you give us ?

Mr. LUCK. Our country probably could not be irrigated from streams, as it is a kind of high rolling country ; but it has lots of hollows, and if artesian wells could be sunk that would afford a sufficient flow of water to fill these basins and succession of ponds we could irrigate pretty nearly the whole country.

The CHAIRMAN. That is to say if the artesian wells would furnish sufficient water ?

Mr. LUCK. Yes.

The CHAIRMAN. Suppose they would not, could you do something in the way of saving the storm water ?

Mr. LUCK. Yes; we could save some, and some of the little creeks could be banked up, and the water in them could be saved. In that way quite a good deal of the country could be irrigated, but not all of it.

The committee resumed session at 7 p. m.

Present, Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF JOHN M. TURNER, OF MANDAN, BURLEIGH COUNTY.

The CHAIRMAN. What is your occupation ?

Mr. TURNER. I am manager of the Mandan Roller Mill Company.

The CHAIRMAN. How long have you resided in Mandan ?

Mr. TURNER. About one year, but I have lived three years in Dakota.

The CHAIRMAN. In what part of Dakota have you resided ?

Mr. TURNER. I was traveling in the eastern section, along through the Red River Valley particularly and as far west as the James River. I had no knowledge of the West Missouri country until about a year ago. About the 1st of January last I became interested in the Mandan Roller Mill Company and was appointed manager of their mill.

The CHAIRMAN. Are you now quite familiar with this country west of the river ?

Mr. TURNER. Yes, sir.

The CHAIRMAN. State whether or not it suffers from want of moisture ?

Mr. TURNER. It suffers very materially from want of moisture. The roller mills were built three years ago, with a capacity of three hundred barrels a day, which would require 300,000 bushels of wheat. We have not, however, been able to get anything like that. We have tracts of land amply able to provide us with wheat for ten such mills if we had the necessary water. This spring—that is to say, about the last of May and first of June—we anticipated that we would have a crop of half a million bushels. Then the hot winds came, or, as some people here call them, the chinooks, and in three days' time our crops were reduced to 75,000 bushels west of the river, according to the best estimates that we have been able to make. There was no moisture whatever in the atmosphere during that time. The wheat crop was fatally injured. The flax, which was ripening about the 1st of July, escaped, and is doing better. Oats promised fairly well. The hay crop, which came after the chinooks, is doing fairly well now.

The CHAIRMAN. What are facilities for furnishing water for irrigation? Have you looked into that at all? Have you any streams that can be diverted or places where water can be stored?

Mr. TURNER. From my knowledge of the country I should say not, because our streams run through low lands, and are weak in the summer time.

The CHAIRMAN. You would have to store water from the small streams in order to have water during the irrigating seasons?

Mr. TURNER. Yes, but the character of the country is such that I doubt whether reservoirs would be feasible.

The CHAIRMAN. You have flat land, have you not?

Mr. TURNER. Between our hills only. The surface of the country is rolling. There is very little flat land, except on plateaus.

The CHAIRMAN. Do you not suppose that you could find on every quarter section a place for a reservoir? Suppose you wanted to make a fish pond for pleasure, could you not find a place for it?

Mr. TURNER. Hardly on every quarter section. But I think we could on every half section, by dividing a section into two probably diagonally. On some sections we might find a hole for that purpose.

The CHAIRMAN. Do you want a hole for that purpose? What you want is a water-shed, isn't it?

Mr. TURNER. Yes, but my mind was running in the direction of artesian wells, rather than getting water from streams.

The CHAIRMAN. My mind was on the catchment idea; not in the direction of artesian wells. If you had artesian wells, is there any difficulty about getting water?

Mr. TURNER. I don't think so. I think we could perhaps get artesian well water. We have a company organized now with a view of looking into that.

The CHAIRMAN. That will be very good. There is a belt running north and south along the James River that probably would give artesian water. The difficulty about that, and I must warn you to-day, is this: Many artesian wells are small, and have but a small water-shed to supply them. When you sink a good many wells you exhaust the source of supply. This is the largest belt I ever saw, and if it has its source of supply in the Rocky Mountains, as we think it has, it will be of great service. We are now making an examination of the country with the view of conducting further surveys and explorations to ascertain what can be done. In Dakota I think some good work can be done in the way of surveys and explorations, that will give the people a good deal of information.

Mr. TURNER. We have something on the west side of the river that we don't have on the east side, which is coal. I also find from my experience in milling that the alkali surface on lands gives us a much stronger berry of wheat. We have winds there blowing 30 or 40 miles an hour in the summer season, and I never saw any wheat in the East that would stand that. The nature of the surface-water is such that the cattle will drink it at some points, and at some they will not. We have, for instance, in one place a tube driven down into the ground and a pump attached to it, and we get water from that. Those pumps sustain us. We had a fire at our place, and we were able to hold the flames in check. That is an evidence to us that there is water everywhere around us. We have with us to-night Mr. Clark, of Mandan, who is probably the best posted man in that section of the country.

STATEMENT OF J. R. CLARK, OF MANDAN, BURLEIGH COUNTY.

The CHAIRMAN. Please state to the committee your views with regard to irrigation; whether it is needed in this section, and how it may be obtained?

Mr. CLARK. I can not claim to be an expert, or even to be well posted in this matter; but my idea is, that we must depend altogether upon artesian wells for our supply, rather than our streams. Some sections can be irrigated by the reservoir system from overflow or surface water.

The CHAIRMAN. For the purpose of irrigation there are three sources from which water may be had: First, the streams, if they can be diverted with ease; secondly, reservoirs, and those reservoirs may be used, where there are no streams, to save the storm waters—they may be used also for the purpose of increasing the water in the streams, letting the water down at the proper time; third, artesian wells. Where you can strike a good artesian belt you can get considerable water. From what we have seen of this artesian belt a little east of here, if it proceeds from the Rocky Mountains, it is the best artesian-well belt in this country, and probably the best in the world.

Mr. CLARK. Undoubtedly the trend of the strata is all due east, judging from the incline or dip of the country from the Rocky Mountains to this point. The Missouri River is the first material break in that slope.

The CHAIRMAN. Jamestown, I think, is supplied from the Rocky Mountains, though I may be mistaken in that. If it is, you have the artesian belt here, of course.

Mr. CLARK. We think so, and we are about to test it shortly. But that is about the only hope I have of successful irrigation here.

The CHAIRMAN. I thought there were sources of water supply here besides that. Some gentlemen were speaking of some stream running into the river here on the west side.

Mr. CLARK. About 15 miles away we have the Cannon Ball; then right at the town we have the Heart, and then beyond that we have the Butte. Those are none of them strong streams, however.

The CHAIRMAN. Do they go back a long distance?

Mr. CLARK. About 150 miles. We can probably save at the time of overflow in the spring the surplus water.

Mr. LUCKY. The banks east of New Salem are at least 100 feet below the plateau, so that to irrigate from the Heart you would need a dam 100 feet high.

The CHAIRMAN. Of course, if the stream gets down into a deep cañon, you can not get it again. But it seems to me you can go above and save a good deal on the water-sheds, by making dams and finding low places and bringing the water to the plateau. Could not that be done?

Mr. CLARK. I think so.

The CHAIRMAN. If you keep the water until summer it would be just as well as if it flowed during the summer season?

Mr. CLARK. Undoubtedly.

The CHAIRMAN. If you have streams of that kind you had better experiment with them.

Mr. CLARK. I have some figures here giving the altitudes. Those waters rise at the divide. Freiburg is 136 miles west of here by rail. The altitude of that place is 2,800 feet, while the altitude of Mandan is

1,625 feet. So that we have in that 136 miles a fall of 1,175 feet. That applies to the river Heart especially.

The CHAIRMAN. What is the other stream?

Mr. CLARK. The Cannon Ball. That is the dividing line between the northern limit of the eastern reservation and our county.

The CHAIRMAN. Then there are three or four of those streams. What is the character of the land between them and the plateau?

Mr. CLARK. The land is broken. There are some tracts of level land or plateaus, and then there is some land which is very much broken.

The CHAIRMAN. By surveying you could probably find a line for a ditch. You could get a ditch on the high ground, and then the water might percolate from it?

Mr. CLARK. Perhaps so.

The CHAIRMAN. It seems to me that it would be a good idea for the people here, situated as you are, to send somebody to Utah and Montana and take a look at what has been done there. If necessary you could send for some man who has had experience and is familiar with the practical bearings of the question. You can learn more by seeing things than by talking about them.

Mr. CLARK. That is so. Everybody has theories, but that does not bring the things down to practical knowledge.

The CHAIRMAN. I think that if you had two or three practical engineers from Colorado and California who know all about irrigation, they would be worth a good deal to you. It took the people of those States a quarter of a century to find out what they now have. So far as you are concerned you don't want to wait a quarter of a century.

Mr. CLARK. No, sir; we are tired already of waiting so long.

STATEMENT OF JAMES BELLOWS, OF MANDAN, BURLEIGH COUNTY.

The CHAIRMAN. You have resided in Mandan how long?

Mr. BELLOWS. Ten years. I am one of the oldest inhabitants there now.

The CHAIRMAN. You are doubtless acquainted with the country about here?

Mr. BELLOWS. I built the railroad from the Missouri River to the Yellowstone. That gives me some knowledge of the lay of the land.

The CHAIRMAN. What do you say about the necessity of irrigating that country?

Mr. BELLOWS. During the ten years we have been here we have had two good crops. Every other year we have had very fine prospects but the long drought has deprived us of the small grains, such as wheat and oats. This year we thought we were going to have good crops. The crops that were on low ground and were put in pretty deep, seemed to withstand the dry season better than the others.

The CHAIRMAN. Are you an engineer?

Mr. BELLOWS. No, sir.

The CHAIRMAN. From what you have seen of the country, would there be any difficulty in irrigating some of this land from these streams?

Mr. BELLOWS. Not if we had money enough with which to do it.

The CHAIRMAN. It does not take money; it takes work.

Mr. BELLOWS. Well; work costs money. There is no doubt but what we could bring water from the head waters of the Heart River on to Custer Flats, and on to the rise of the land. Across the river we have

50,000 acres that lie 300 or 400 feet, I suppose, above the Heart River. That is a pretty piece of land, and very fertile. If we could get the water there on any one spot we could irrigate the whole of Custer Flats.

The CHAIRMAN. Could you not take the Heart River and use it and then bring it down? If it is like all other streams—the little streams that feed it find their head in hollows and little places, where you can store the waters. Perhaps there are fifty or a hundred such places.

Mr. BELLOWS. Oh, yes; there are places enough for storage.

The CHAIRMAN. That would be a feasible scheme, would it not?

Mr. BELLOWS. No doubt of it.

The CHAIRMAN. If the Government should make surveys for you, and give you estimates, etc., wouldn't they be a great assistance to the people here?

Mr. BELLOWS. It undoubtedly would. If this section of country could have sufficient water it would be found to be a mine of wealth.

The CHAIRMAN. An examination which would result in showing how these places could be irrigated would enable the people about here to do a good deal for themselves, would it not?

Mr. BELLOWS. Yes, sir.

The CHAIRMAN. Who owns these 250,000 acres of land?

Mr. BELLOWS. They are owned almost wholly by the railroad company.

The CHAIRMAN. They can not own more than one-half of it surely.

Mr. BELLOWS. I mean that it is unsold land, except a small portion of it, after you go back pretty well from the railroad.

The CHAIRMAN. I don't think I ever saw such an opportunity to make money as there is here, if a man will only get this land and irrigate it. The land will not cost him more than \$1.50 to \$2 per acre, and it can be made worth \$30 or \$40 an acre, mostly by labor. As quickly as you establish the fact that you can reclaim farms here, and as quickly as you let people see what can be done by irrigation, you will have a great rush into this country. People will come here from all parts to settle.

Mr. BELLOWS. From results which I have made in my garden this summer, I can see that a great deal can be done by irrigation. I have had plenty of water in my garden, and I find that I can raise everything that I want without manure or anything of that sort.

The CHAIRMAN. The water of the streams will keep your land perpetually rich. In that respect it is very different from rain-water. This water from the streams brings down silt. Some people spread the water over the land specially for the purpose of fertilization. They are doing that in France and in other countries where they have already rain-fall enough. They put on the land water that flowed down from the mountains, because it brings this silt with it. The Valley of the Nile has produced crops for four thousand years, and has seldom missed a crop. That land, of course, is flooded every year. You could club together here, I should think, and build a ditch of 25 miles or so. If you have not water enough to answer your purposes you could build dams and have a number of reservoirs. But if you have a ditch dug, from what I have seen of the land east of here, with this clay subsoil, I believe you can irrigate it at any season of the year and soak the land thoroughly, and it would be sufficient to give you a good crop.

Mr. BELLOWS. The land all through here has a clay bottom. There are a good many little streams coming into the Heart, but I suppose they could flume them.

The CHAIRMAN. They could either do that or dig around.

Mr. BELLOWS. To dig around them would require many miles of digging.

The CHAIRMAN. If you get a place where you can't flume, you could get a light iron pipe and carry it across. A very light pipe will carry water across these gullies.

Mr. BELLOWS. Yes, sir; they are using wrought-iron pipe now which is very cheap. Your suggestion is one that had not occurred to me at all, as I have looked upon it as too expensive a project for the few of us who are here. The only thing that occurred to us as practicable was the artesian well.

The CHAIRMAN. The artesian well may be successful, and it may be all that you want; but the experience of mankind as to artesian wells is that you can not expect too much water from a large number of them. This, however, is the most marvelous belt of artesian well-water that I have ever seen. After going through a sedimentary formation, they strike a hard capping above the water-bearing stratum, and then they strike a loose sandstone or coarse sand, about 75 feet, I believe, being the greatest depth of it. That is an immense water-bearing stratum, and this problem arises with regard to it: If all that water is supplied from a small water-shed somewhere, into which the water has come and in which it has remained, and if it is without a large continuous supply, then it will fail in time. If, on the contrary, this sedimentary formation or great bed of sandstone extends from that point to the Rocky Mountains, and is there uptilted, as long as there is a great body of snow in the mountains it will probably continue to furnish an immense volume of water.

Mr. BELLOWS. The fact that they get water all the way from Yankton through to Jamestown is wonderful.

The CHAIRMAN. It is very remarkable, and also that they get it in the same body of sandstone. It comes from somewhere up here, and it probably comes from a long distance. I think if you people here would sink a well it would irrigate three or four sections of land, and you would be much better off next year than you are this.

Mr. BELLOWS. If an artesian well is a success here we have lots of farmers here that will sink wells just for their own farms.

The CHAIRMAN. If they do as well as the other artesian wells we have seen they will do more than water any one farm.

Mr. BELLOWS. Some of the farms here are pretty large. Mr. Lyon, who is now present, has a very large farm, and instead of having a few bushels of wheat he might just as well have forty to the acre. In the Gallatin Valley, through which I passed one summer, I never saw finer crops in my life than I saw there.

The CHAIRMAN. Then, besides the raising of wheat, you can raise everything, and you will have an all-round farm on which you can grow corn, peas, beans, tomatoes, potatoes, and everything that will grow in this latitude. Besides that you can have good trees. I should think, too, that this would be a good country for small fruits.

Mr. LUCKY. They will do well if they are watered in the dry season. I have a number of raspberry bushes, and gooseberry bushes, and other berries of that sort. We must, however, have water.

You have been speaking about irrigating the land from Heart River. In our country it would be cheaper and better to take the water from the Missouri River, I think. That lies just as high, and with a big bend. From the other we can not get the water very far. The Missouri flows very swiftly and constantly, and that would give us irrigation better than the Heart or any other stream.

The CHAIRMAN. This question is as to how to do it. It is one that we can not determine here. It is an engineering question.

Mr. LUCKY. I think that if we could get artesian wells, the way the country lies, we could irrigate enough by sinking them on high points.

The CHAIRMAN. If I were living here I should bore artesian wells with a good deal of confidence that I should get water.

Mr. BELLows. I have great confidence, too. I am not a geologist, however, although I have associated a good deal with geologists, and have read considerable in geology.

STATEMENT OF LYMAN N. CARY, OF MANDAN, BURLEIGH COUNTY.

The CHAIRMAN. What is your business?

Mr. CARY. Real estate.

The CHAIRMAN. What is the topography of the country on the other side of the river?

Mr. CARY. It is rather broken.

The CHAIRMAN. Would there be any difficulty in running a line of ditch up some of those streams and getting water?

Mr. CARY. I do not think that it is practicable. I do not profess, however, to be very competent to judge on that subject. I have always been looking for a place on the streams where we could have a natural pond or lake, some hollow place into which water could be turned, but I never found any that would hold much water without going to a great deal of expense to prepare it.

The CHAIRMAN. Have you examined the Heart River?

Mr. CARY. Yes; I have been all over that country thoroughly; we have been local agents for the Northern Pacific Railroad.

The CHAIRMAN. In order to get the water on to this 50,000 acres of land, spoken of awhile ago, how far would you have to go up the river so as to get to a point in the bed of the river which would be on a level with the point at which you would want to discharge the water?

Mr. CARY. I should think probably 50 miles would carry it there. But it is difficult to get there, because there are so many ravines on the way. To run the line level for 50 miles east along the bluffs would take probably fully 25 miles of linear measure. Unless some provision was made for carrying it over the ravines I do not think it would be practicable.

The CHAIRMAN. It could be carried over the ravines by means of flumes, could it not?

Mr. CARY. Probably.

The CHAIRMAN. And by means, in some places, of pipes?

Mr. CARY. Yes. I should think that could be done, but that would be an expense greater than the farming interests at the present time would warrant.

The CHAIRMAN. I presume it would be a great deal of expense. Is there any probability of going up higher on the river and taking the source of it down?

Mr. CARY. On all the little creeks and streams that might be done, but I think our water supply is to be looked for from wells. I think we could get from the little streams some water, but they would soon be exhausted.

The CHAIRMAN. Could you not store water?

Mr. CARY. Not without flooding the very valley that you would ex-

pect to irrigate. I would not expect to take any of it from the table-lands.

The CHAIRMAN. You could flood the head of it and use the balance. You would not expect to get it from the table-lands at all?

Mr. CARY. Our streams are long, and for many miles from the source they are very weak.

The CHAIRMAN. They are not weak at certain seasons of the year.

Mr. CARY. They are strong in the spring. But the flow is not great, and in order to dam them to any great extent, you would require to get quite an area.

Mr. T. S. UNDERHILL. If you will allow an interruption, I would remark here that we were on these streams this afternoon. The suggestion, Mr. Cary, is whether or not up on the Green River, which is a branch of the Heart, we could not on these headwaters have immense reservoirs, sufficiently high up to bring them over the table-lands down through the whole country.

Mr. CARY. I think that such a thing could be done.

Mr. LUCKY. There would not be supply enough to water the whole country. In order to do that I should say the Missouri would be the proper thing.

Mr. J. W. SHAW. Would not that cost millions of dollars?

Mr. CARY. If we could get water by artesian wells, that would be the thing.

The CHAIRMAN. You could undoubtedly get a large amount of water. But when you come to discuss the question of getting water enough to water the whole country, that is hardly possible.

Mr. CARY. We have a broken country, and I think it could be conducted around so as to utilize all of the water that could be taken, without waste.

The CHAIRMAN. I don't see why you need to have any waste; if you get the water up on a knoll, it could be carried around in a circle and then brought down. This water comes up so warm that it would hardly freeze in winter, does it not?

Mr. CARY. It would freeze before it went very far, in cold weather.

WATER AND DITCH COMPANIES.

The Secretary of the Territory of Dakota filed with the committee the annexed list of irrigation and water-storage companies, as recorded in his office up to August, 1889:

1. The Lone Tree Ditch Company, Rapid City.
2. The Rapid Valley Ditch Company, Rapid City.
3. Black Hills Ditch Company, Rapid City.
4. Butte County Irrigating Ditch Company.
5. Lower Rapid Ditch Company, Rapid City.
6. Butte Creek Irrigating Ditch Company, Butte River.
7. Brown's Irrigating Ditch Company, Rapid City.
8. The Western Improvement Ditch Company, Rapid City.
9. The Elm Grove Ditch Company, Elm Grove.
10. The Central City Water Company, Central City.
11. The Deadwood Water Company, Deadwood.
12. The Rapid City Water Works, Rapid City.
13. Bismarck Reservoir and Water-Works Company, Bismarck.
14. Fargo Water and Steam Company, Fargo.
15. The Mutual Water Company of Dakota, Rapid City.
16. Bismarck Artesian Well and Water-Works Company, Bismarck.
17. The Bear, Butte, and Elk Creek Water Company, Deadwood.
18. Gayville Water and Mining Company, Gayville.

19. The Black Hills Canal and Water Company, Lawrence County. San Francisco, Cal., principal place of business.
20. Rockville and Teepe Ditch and Flume Company, Rockville.
21. The Rapid City Water Company, Rapid City.
22. Box Elder Water Company, Pinkerton.
23. The Bay State Water-right and Ditch Company, Lead City.
24. Bear, Buttes, Strawberry and Ruby Gulch Water Company, Deadwood.
25. The Boston and Little Rapid Milling and Water-Power Company, Rochford.
26. The Butte Irrigating Ditch Company, Butte, P. O.
27. Rapid Valley Irrigating Company, Rapid City.
28. The Wacum Ditch and Flume Company, Deadwood.
29. Rapid River Ditch and Improvement Company, Rapid City

RESOLUTION AND MEMORIAL OF THE STATE CONSTITUTIONAL CONVENTION OF NORTH DAKOTA.

Resolved, That this Convention submit to the United States Senate Committee on Irrigation and Reclamation of Arid Lands, the following memorial:

To the honorable United States Senate Committee on Irrigation and Reclamation of Arid Lands:

GENTLEMEN: The Constitutional Convention for North Dakota duly assembled at Bismarck under the enabling act passed at the last session of Congress representing the people of North Dakota, familiar with their industries and pursuits, with their resources and necessities, has learned with interest and gratification that it is the expressed purpose of your honorable committee to enquire into the needs of North Dakota in the matter of artificial water supply.

To North Dakota this is a subject of such exceeding importance, that this convention is moved to memorialize your honorable committee and through you the Senate of the United States, as follows:

First. We beg your attention to the fact that the great fertility of the soil of North Dakota has been shown by many seasons of sufficient rain-fall.

Second. The superiority of the grain grown in this soil, and especially of the wheat, is now a matter of repute throughout the civilized world, and is a contribution to the fame of our national resources. In the United States this wheat is almost a necessary ingredient of fine flours.

Third. That these facts have attracted to North Dakota a population of 250,000 earnest, sober, law-abiding people, possessed of a purpose to develop the land, and who have already made it a source of wealth and importance to the nation.

Fourth. That it is now demonstrated and understood that the peculiar excellence of the cereals of North Dakota is the result of climatic conditions as well as of qualities of the soil; that one of these conditions is the dryness of the climate, which, however, in seasons of average rain-fall in the most parts is not so excessive as to prevent yield of crops unsurpassed in other parts of the land; but that this desirable average implies seasons in some parts of North Dakota of insufficient precipitation, disastrous to agricultural prosperity and discouraging to farmers.

Fifth. Therefore we earnestly urge upon the honorable committee and upon the United States Senate these considerations:

(a) We recognize and approve the object before your committee—namely, the initiation of investigation and certain work at the expense of the General Government looking to the establishment of reservoirs or other systems for the irrigation of lands in need thereof, to the end that the area of public agricultural lands may be greatly increased.

(b) We also realize the fact that such enlargement of area means direct and formidable competition with the industries of North Dakota, (competition especially to be dreaded since irrigated farms are the most productive in the world), while already overproduction has deprived farming of nearly all profit.

(c) We recall to your attention and to that of the honorable body which you represent, the fact that the people of North Dakota have paid into the Treasury of the United States many millions of dollars for their lands, while proposed expenditures for mountain reservoirs are mainly intended to benefit regions from which comparatively nothing has been received from sales of agricultural lands.

(d) While therefore we do not question the benefits to accrue from expenditures for the mountain reservoir systems, we feel justified in claiming some similar expenditure for North Dakota, and a share in the paternal solicitude of the Government to this extent, namely, that suitable investigation, to be followed by experimental work, be made in behalf of North Dakota, to ascertain whether or not it is practicable to provide by means of artesian wells sufficient water to eliminate the dangers incident

to dry seasons, and to maintain the agricultural industries of the State on a footing for competition in grain production, upon which its inhabitants absolutely depend for support.

We therefore trust that your honorable committee will give to North Dakota more than a passing glance, that you will conduct an investigation with reference to its resources and its necessities and make a report thereon which will result in the development of the former and secure if possible relief from the latter.

We beg you to notice that while there are certain ascertained artesian basins the extent of such basins has not been accurately ascertained.

Scientific experiment and survey are needed to determine this matter as well as the character of the water to be obtained and its influence on vegetation. Other essential facts to be ascertained will suggest themselves to your committee—the whole of a scope too great for North Dakota to undertake at the expense of its people now engaged in their early struggles to establish themselves.

We confidently believe that the outcome of such work by the Government in North Dakota will be to return to the Treasury many times the amount of its expenditure in the further cash entries of government lands.

We hereby certify that the within memorial was introduced and passed by the Constitutional Convention of North Dakota, and is a part of the permanent record thereof.

F. B. FANCHER,
President.

JNO. G. HAMILTON,
Chief Clerk.

Adjourned.

MONTANA.

GLENDIVE, *August 6, 1889.*

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF J. R. MEADE, OF GLENDIVE.

The CHAIRMAN. How long have you resided at this place?

Mr. MEADE. Since 1880.

The CHAIRMAN. Have you made any efforts in this vicinity to fertilize the land by irrigation?

Mr. MEADE. Not to any great extent. There are some two or three ranches that are irrigated.

The CHAIRMAN. Where?

Mr. MEADE. Mr. Bennett has a ranch on the other side of the river, about 10 miles from town.

The CHAIRMAN. Above or below the town.

Mr. MEADE. Above.

The CHAIRMAN. To what extent has he irrigated and with what success? Have you ever seen the ranch?

Mr. MEADE. Yes; but I have not seen it in the dry season. His creek goes dry when he wishes to irrigate. If it does not go dry about the 1st of August, it is a success. But it generally goes dry just as he wants to use it. Down the river 75 miles Mr. Dunlap has a stream of water, and I understand it is a success. He uses his farm for raising crops: corn, potatoes, oats and all kinds of vegetables.

The CHAIRMAN. What kind of hay does he cultivate?

Mr. MEADE. Timothy and wild grass.

The CHAIRMAN. How successful has he been in that direction?

Mr. MEADE. I understand the timothy is 2 tons to the acre.

The CHAIRMAN. Have you ever raised alfalfa in this vicinity?

Mr. MEADE. If alfalfa has been put in, it is not to my knowledge.

The CHAIRMAN. Has anybody tried to cultivate it?

Mr. MEADE. That I can not answer.

The CHAIRMAN. Where does Mr. Dunlap get his water?

Mr. MEADE. It is from a spring.

The CHAIRMAN. He has not tried to turn the water from the river?

Mr. MEADE. No; it is water from his spring.

The CHAIRMAN. I believe you said there were three parties who were irrigating.

Mr. MEADE. There are several on a small scale, but I think those two are the only ones whom we consider as having sufficient water.

The CHAIRMAN. What distance is it from the commencement of these valleys up the river to the Missouri River?

Mr. MEADE. From here to the Missouri River?

The CHAIRMAN. No; where the valley commences west, above, to where you get to the Missouri River, below.

Mr. MEADE. I should say from Livingstone, the mouth of the river, three or four hundred miles.

The CHAIRMAN. Have you ever estimated the average width of the valley land?

Mr. MEADE. Four or five miles it would be, in my opinion—probably from 3 to 5 miles.

The CHAIRMAN. It would average 4 miles, would it?

Mr. MEADE. I should think it would.

The CHAIRMAN. Is it all level land on both sides?

Mr. MEADE. I should take it to be for 3 miles.

The CHAIRMAN. Three miles in width and 400 miles in length, would be 1,200 square miles.

Mr. MEADE. That is only an estimate.

The CHAIRMAN. How many acres would that be—768,000 acres of land, would it not?

Mr. MEADE. That is a large body of land.

The CHAIRMAN. So far as you have examined, this land is all smooth and level?

Mr. MEADE. Yes. I should say that the Yellowstone Valley in this vicinity was 40 miles in length; the bad lands then come in, as they do here.

The CHAIRMAN. But, then, there is a valley on one side or the other?

Mr. MEADE. In nearly every case, yes. For instance, by the Yellowstone River there would be bad lands for 30 miles and over, and then there would be good lands on the other side.

The CHAIRMAN. I believe there are some lands up in the valley where they do irrigate?

Mr. MEADE. I understand so.

The CHAIRMAN. Have you ever seen them?

Mr. MEADE. Yes.

The CHAIRMAN. Where is that?

Mr. MEADE. At Billings. They have a ditch at Billings. I have never seen it to any great extent except from the cars.

The CHAIRMAN. Have any steps been taken to reclaim this land by irrigation?

Mr. MEADE. Not to my knowledge; not to any extent. Nothing has been done in the way of water from the Yellowstone River—only from the local streams. There are three places where they irrigate largely; but I suppose there are a dozen places where they irrigate by springs.

The CHAIRMAN. What kind of crops do you plant here?

Mr. MEADE. Corn is small, on the average; not as large as the Illinois corn, but it will run 30 bushels to the acre. There are potatoes and wheat and oats. Everything except large corn requires a long season.

The CHAIRMAN. What is the length of your season, from the late frosts in the spring that would kill vegetation until the early frosts in the fall?

Mr. MEADE. That would average from the first of May to the first of September.

Senator REAGAN. That would be four months?

Mr. MEADE. Yes; we generally get the first frost the fore part of September.

The CHAIRMAN. Does the corn that is raised in New England mature here?

Mr. MEADE. Yes,

The CHAIRMAN. How about wheat?

Mr. MEADE. Sometimes the wheat will do well on the table lands; but that is uncertain, as it is in Dakota. But wherever you have water it is a success.

The CHAIRMAN. In every instance?

Mr. MEADE. Yes. We have land down the river, 40 or 50 miles, low buck-brush land, where they get 50 bushels to the acre.

The CHAIRMAN. Wherever that grows, there is good land?

Mr. MEADE. Yes.

The CHAIRMAN. What kind of brush is that?

Mr. MEADE. Low hazel-brush.

The CHAIRMAN. How is it where sage-brush grows? Is sage-brush an indication of good land in this country?

Mr. MEADE. Yes. I understand it is deep soil, but it requires water to use it, because the ground is so porous.

Senator REAGAN. Have you ascertained how far you would have to go up the valley to get water to irrigate the land at this place?

Mr. MEADE. On the opposite side of the river it would be 30 or 35 miles. It has been looked over here by a cattleman who was an engineer, and he talked it up for a number of years very strongly. At Ferry Point it could be taken out cheaply. That is 30 or 40 miles from Glendive. Then you would strike lowlands. That place in particular, in the opinion of a practical engineer, would be a very good place for a ditch.

STATEMENT OF JAMES G. RAMSAY, OF GLENDIVE.

The CHAIRMAN. How long have you resided here?

Mr. RAMSAY. Since 1882.

The CHAIRMAN. What is the paper or map which you have in your hand?

Mr. RAMSAY. It is a rough sketch of the Yellowstone—what is called Lone Horse Prairie. It is not quite accurate. It was made from the best information that could be obtained without really surveying. It is made on the reports that I have had from Mr. Clark. He was a mining engineer for a long time, and he was in the cattle business here. He had a ranch near the Bad Route, and he took the trouble to run a level to see whether he could get water out of the Yellowstone. Mr. Clark says that at Ferry Point, which is 35 miles on the other side of the river and on the lowland—the second land is bench land—to get the water on the bench land you would have to go 6 or 7 miles, and that there would be some fluming to get around the bluff. It is in June that they need water in this place, and they always have water in the Yellowstone before that time. Here is a rough sketch showing the land from Ferry Point to Glendive [producing paper].

The CHAIRMAN. The valley continues on the other side of the river?

Mr. RAMSAY. Yes, for 30 miles. In some places the bluffs come close to the river and you would have to flume the water to get it out.

The CHAIRMAN. How much land could you irrigate?

Mr. RAMSAY. All the way from the mouth of the river, 115 miles, and for $2\frac{1}{2}$ to 3 miles wide.

The CHAIRMAN. To get to that body on the other side of the river would you need a flume?

Mr. RAMSAY. Yes; below Glendive the river bottoms are wider than they are here.

The CHAIRMAN. And wider than above?

Mr. RAMSAY. Yes. I think a safe estimate would be an average of 2½ miles to Ferry Point.

The CHAIRMAN. How much land have you under that ditch? [Indicating on map.]

Mr. RAMSAY. As a rough estimate, 65,000 acres.

The CHAIRMAN. Has there been any opportunity here to enter into such an enterprise?

Mr. RAMSAY. Not yet. Some years ago some one sent a man here to see about it, and he put in a couple of ditches. But there has been nothing heard of it since. Mr. Bennett has taken a little water out of Clear Creek and irrigated 160 acres.

The CHAIRMAN. With what success?

Mr. RAMSAY. He is here himself and can tell you all about it. In 1882 and 1883 there were a good many settlers who took up a good bit of land, and now there are about seven families left.

The CHAIRMAN. Why did they quit?

Mr. RAMSAY. They could not raise sufficient crops without irrigation.

The CHAIRMAN. Did they try to irrigate?

Mr. RAMSAY. Along this strip of land here [again indicating on map] they have got in a spot where there is a little soakage or leakage, and there they raise small crops. Some years they raise a pretty good crop. There is a ranch about 5 miles from here where they have been raising crops from irrigation. I might say in regard to this point [indicating on map] that there is a rock bottom in the river, and there are rapids above.

The CHAIRMAN. That presents an invaluable place to take out water?

Mr. RAMSAY. Yes. There are rapids there, and the fall is greater right at that point [indicating] than any other place in the river. Mr. Clark says that by making the head of the ditch at that point it could be done with little expense compared with the balance of the river, because most of the banks along the other places are sandy.

The CHAIRMAN. Will we see that point as we go along on the train?

Mr. RAMSAY. You can see it from this point [indicating]; but you would not have much of an idea from this side of the river. The road on the other side of the river goes a mile and a half from the river, and the place of which I have spoken is on this side.

STATEMENT OF J. H. RAY, OF GLENDIVE.

The CHAIRMAN. How long have you resided here?

Mr. RAY. Between seven and eight years.

The CHAIRMAN. What is your profession?

Mr. RAY. That is a pretty hard question to answer at present. I am rather gathering up specimens, fooling around at the present time. I have no fixed occupation at present.

The CHAIRMAN. You are a justice of the peace?

Mr. RAY. Yes; and I am a United States commissioner, which is a little bigger office than justice of the peace—having a little more jurisdiction.

The CHAIRMAN. Are you familiar with this country?

Mr. RAY. Yes; I have traveled over this country a good deal—probably 100 miles east and west.

The CHAIRMAN. Across the river and this side, what lands do you find back from the river?

Mr. RAY. After leaving the water-course, we find sloping prairie. Wherever we strike water-courses we strike prairie land.

The CHAIRMAN. How far back from the water-courses before you strike the prairie?

Mr. RAY [indicating on the map]. Following up one of these draws, we strike it there upon the top of that butte. That is level.

The CHAIRMAN. That is about 500 feet above the level?

Mr. RAY. I think it is 360 feet from the base. I measured it with a barometer, and it is about 400 feet from the river bed.

The CHAIRMAN. Is that about the height of the plateaus on both sides?

Mr. RAY. On the other side the flat places are bad—they are precipitous.

The CHAIRMAN. When you get back on the plateaus or uplands, is that about the average height?

Mr. RAY. It rises gradually, probably until you get up to the altitude of 600 or 700 feet.

The CHAIRMAN. How is it then? Is it smooth and level land up there?

Mr. RAY. Oh, yes. After you get up on the divide it is very rich land, and vegetation grows very rapidly there.

The CHAIRMAN. What is the extent of that character of land on each side?

Mr. RAY. I have found it as far as I went.

Mr. CHAIRMAN. Then there are extensive plains on both sides of the river?

Mr. RAY. I have been out 100 miles south of the river several times, and always found a plain of that character.

The CHAIRMAN. When you get down on the base land, is it smooth, level land?

Mr. RAY. Yes; after you get away from the water-courses.

The CHAIRMAN. We want to know the situation up there. When you get up there it is a large extent of country; but do you know how much there is of level country?

Mr. RAY. With the exception of just around the bluffs it is all level.

The CHAIRMAN. After you get away from the buttes?

Mr. RAY. I am talking about the bluffs and not the buttes. After you get away from the bluffs it is all level country.

The CHAIRMAN. Is there any chance from any source to get water onto that level country?

Mr. RAY. Why, yes; I think there is the greatest kind of chance to get water.

The CHAIRMAN. From what source would you get water?

Mr. RAY. Take the altitude of Glendive, which is, say, between 2,100 and 2,200 feet from the level of the sea. From here to Livingstone it is 125 miles, and the fall of the river is, on an average, 16½ feet per mile, making some 2,200 feet. It is higher here than there, and you could take that river there and carry it anywhere, could you not?

The CHAIRMAN. You could; but it would be a very expensive job. I do not know but what there would be some other source of supply by going up higher in the mountains.

Mr. RAY. There is the Tongue River and the Powder River.

The CHAIRMAN. We cross them as we go up.

Mr. RAY. Yes; but I have no faith in being able to irrigate from tributaries, because they go dry just when you want water. There is a point [indicating on map] that they call Ferry Point, 30 miles above

here, where you could take out the Yellowstone and carry it down here [still indicating], and you would have a grade of 150 feet above the river. But by the time you get to the mouth of the river you would have 600 or 700 feet, and the uplands are as fertile as the bottom lands. The rain-fall follows the divide.

The CHAIRMAN. When you get down to that point [indicating] do you have the little hills that they have in Dakota, or is it smoother land?

Mr. RAY. Were you ever through Wisconsin above Madison? Well, it is just such a piece of country as that. There are high bluffs and foot-hills. The configuration is just about the same as it is at Madison, Wis.

The CHAIRMAN. You brought in some wheat with you?

Mr. RAY. Yes.

The CHAIRMAN. Where was that wheat raised?

Mr. RAY. Right on the table-land where this house stands, without irrigation. It was sown in the spring, and there it is; it speaks for itself. It is as good quality of spring wheat as is sown anywhere. The rain-fall here last season was far above the normal.

The CHAIRMAN. When you can raise a crop here without irrigation, it is an exception?

Mr. RAY. We do not get enough rain-fall here to raise a crop, unless it is on the lowlands, when there is an overflow from the ice gorges.

Senator REAGAN. How much of that wheat did you get to the acre?

Mr. RAY. From 20 to 25 bushels to the acre. It stood thick, and the heads are good. You can see from that sample what the berry is.

Director POWELL. Do you think those uplands are better agricultural lands than the bottom-lands?

Mr. RAY. Yes; I think they are as good and sometimes better—more vegetable matter in them. These buttes wash down rapidly, and the grass and vegetation is deeper. I notice that better grass—thicker and stronger—grows on the uplands than in the valleys. It may be on account of more rain-fall, the storms following the divides.

STATEMENT OF NORRIS S. BENNETT, OF GLENDIVE

The CHAIRMAN. How long have you lived in Glendive?

Mr. BENNETT. I have been on a ranch up here for seven years.

The CHAIRMAN. Have you a ranch now?

Mr. BENNETT. Yes.

The CHAIRMAN. How far is it from here?

Mr. BENNETT. Twelve miles.

The CHAIRMAN. On which side of the river?

Mr. BENNETT. On the north side.

The CHAIRMAN. To what extent do you farm there?

Mr. BENNETT. I have a little patch fenced in, and I irrigate some. I run water over about 200 acres in the spring of the year, and have 60 acres that I raise crops on. Then I have some land that I irrigate thoroughly.

The CHAIRMAN. On that which you irrigate thoroughly what is the result?

Mr. BENNETT. Thirty-five bushels of corn to the acre. I was gone last year, however, and did not try it.

The CHAIRMAN. How much wheat did you get?

Mr. BENNETT. There is no way of getting wheat here.

The CHAIRMAN. Have you cultivated any of the grasses by irrigation?

Mr. BENNETT. No; I put in some alfalfa, but the grasshoppers ate it as soon as it came up.

The CHAIRMAN. It grew, did it?

Mr. BENNETT. Yes; it grew.

The CHAIRMAN. Do you have grasshoppers here often?

Mr. BENNETT. No; they have not been troublesome for more than two years. I raised that corn two years ago. [Referring to the samples of corn on the table.]

The CHAIRMAN. That is a good specimen of corn.

Mr. BENNETT. It is not the best selection that I could have made.

The CHAIRMAN. You can raise on irrigated land here all the crops that can be raised in this latitude, can you?

Mr. BENNETT. Yes. I have raised melons. The ground is about 65 feet above the Yellowstone River.

The CHAIRMAN. How did you get the water to irrigate?

Mr. BENNETT. From Clear Lake.

The CHAIRMAN. That is a stream that runs all the time, is it?

Mr. BENNETT. Yes.

The CHAIRMAN. Does it run much water?

Mr. BENNETT. Plenty of water in the spring time, and I run my ditch full about three months.

The CHAIRMAN. How does it affect the wild grass?

Mr. BENNETT. It makes it grow.

The CHAIRMAN. How much of a cutting of wild grass can you get by irrigation?

Mr. BENNETT. About a ton to the acre where it is thoroughly plowed. We have not tried the tame grasses.

The CHAIRMAN. Have you done any farming without irrigation?

Mr. BENNETT. Yes.

The CHAIRMAN. What is the difference between the two?

Mr. BENNETT. Some of this corn was planted outside and was not worth cutting.

The CHAIRMAN. Then you can not raise crops here without irrigation, except in exceptional years, can you?

Mr. BENNETT. No.

The CHAIRMAN. It would be an accident, I suppose, more than anything else, if you should get a crop under such circumstances?

Mr. BENNETT. Yes; I raised melons that weighed 40 pounds, and potatoes that weighed 3 pounds apiece. The creek runs the year round, and the place where we are obliged to take it out there are 4 feet of gravel and it is 30 yards wide. The ditch is about 4 miles long. We think it would be worth perhaps \$1,000 to put in a new dam there.

The CHAIRMAN. You could build dams and reservoirs and do a good deal with this creek, could you not?

Mr. BENNETT. Yes; we built a ditch in 1884 and have had it for 5 years.

The CHAIRMAN. Are you on a railroad section or a Government section?

Mr. BENNETT. I am on a Government section. It is my own now.

STATEMENT OF JOSEPH W. ALLEN, OF GLENDIVE.

The CHAIRMAN. How long have you resided in Glendive?

Mr. ALLEN. Since 1880.

The CHAIRMAN. Have you paid any attention to the subject of irrigation?

Mr. ALLEN. I have.

The CHAIRMAN. Give us any information that you may have in regard to experiments that have been made.

Mr. ALLEN. In regard to the general subject of irrigation, I will say that I first saw it in the Gallatin Valley. I came to Mandan in 1866, and I saw there the general drift of things. I saw that a crop could be had without any difficulty by irrigation. I found further, after years of experience, that irrigation not only produced a crop, but fertilized the soil, from the effects of the water. It probably carried a solution or silt along with it. In 1877 I took up my permanent residence in the Yellowstone Valley at the mouth of the Big Horn, or Pease Bottom, as it was called. That lies on the opposite side of the Yellowstone from this place, and it is about 14 miles long. It was first occupied in 1876 by a party of traders. In 1877, after Custer's death, a party went down there and occupied this place called Pease Bottom, at its head, and put in some crops there. That bottom has been successfully cultivated up to this time without irrigation. There are no means of irrigating it except out of the Yellowstone River, and there are no means of getting the river there. The crops, however, have been good at a place called Baker's Battle-ground, below Billings; it used to be called Colsen. There is a change in the country and its vegetation. There can be crops raised below Baker's Battle-ground, without irrigation, in occasional years. Above that they can not raise anything without irrigation. You can see, if you pass there in daylight, the change in the topography of the country.

The CHAIRMAN. Is the low land affected by the seepage from the river?

Mr. ALLEN. Yes; the low bottom, particularly, lies very low. In regard to this very point I would call the attention of the committee that there is a rock bottom clear across the river, and rock on both sides where the head of the ditch could be taken out successfully. That is urged by some as an objection to taking the head of the river—that you can not protect it there. But there it could be done. The old benchmarks of the United States river surveys are to be seen there. All surveying instruments are corrected there. The fall of the river, the latitude of the country, and everything is corrected from the benchmarks. There are three rapids between Fairy Point and Glendive that must be at least 10 feet of a fall in 1,000 feet.

The CHAIRMAN. How can you account for the fact that men should be so enterprising as to build so many houses as are seen here, and yet leave that fertile land without use?

Mr. ALLEN. I suppose that a ditch from Fairy Point would cost at least \$250,000.

The CHAIRMAN. Would it cost that much to run 5 miles?

Mr. ALLEN. If you were to run it 5 miles you could not irrigate an acre of land.

The CHAIRMAN. If you ran it 10 miles could you then irrigate an acre of land?

Mr. ALLEN. Yes.

The CHAIRMAN. Could you not extend it down as you made it and make money with it as you went along?

Mr. ALLEN. Yes.

The CHAIRMAN. How much would such land be worth if you had it irrigated—I refer to the 60,000 acres of land around here?

Mr. ALLEN. Land of the same kind in Gallatin Valley, and not so rich either, would be valuable land. There are affidavits on file in the clerk's office and the recorder's office in Gallatin County to the effect

that they have raised 105 bushels of wheat to the acre on their land. What that land is worth you can tell as well as I can.

The CHAIRMAN. I suppose that land would be worth from \$75 to \$100 an acre.

Mr. ALLEN. Land that is thoroughly irrigated one year does not require so much water.

The CHAIRMAN. That is our experience everywhere. There is an abundance of water around here, and I have no doubt this land would be worth \$75 to \$100 an acre by irrigating.

Mr. ALLEN. Every acre of it.

The CHAIRMAN. I have no doubt that the land along the Yellowstone is about the paradise for irrigation. It may not be as full in productiveness. At Phoenix, Ariz., and in Kern County, Cal., where they can raise 16 tons of alfalfa to the acre, they have no better land, nor even as good land as this. But you have not been here so long a time. You have frost while they have comparatively none. Still you could produce crops beyond anything that you have ever had.

Mr. ALLEN. The earliest frost we have ever had here, that I can remember, was on the 16th of September. So that we have comparatively long seasons and could produce corn very well.

The CHAIRMAN. There is no place, I suppose, in the United States where there is a larger extent of irrigable land and an abundance of water—for I believe there is an abundance of water in this river; if not, it could be gotten by storing a little, and it would irrigate, I suppose, fully 5,000,000 acres of land. The quantity of land in the Nile Valley that is irrigated and under cultivation is, I believe, about 8,000,000 acres. You have here three-fourths as much as that, and as the water fertilizes the soil, the river bringing down so much silt, you would not need any other fertilizer. At some time this valley will be thoroughly irrigated, and will be noted for the abundance of its crops. I am surprised that the water is allowed to run practically to waste.

Mr. ALLEN. We have not the money to utilize it.

MILES CITY, MONT., *August 7, 1889.*

The committee met pursuant to call of chairman.

Present: Messrs. Stewart (chairman), and Reagan; also Director Powell.

STATEMENT OF GEORGE SCHEETZ, OF MILES CITY, CUSTER COUNTY.

The CHAIRMAN. How long have you resided in Miles City?

Mr. SCHEETZ. Since 1883.

The CHAIRMAN. Are you familiar with the country along the Yellowstone River?

Mr. SCHEETZ. Yes, the Yellowstone and its tributaries.

The CHAIRMAN. Are you an engineer by profession?

Mr. SCHEETZ. Yes.

The CHAIRMAN. Did you assist the county surveyor in making the map that you see here?

Mr. SCHEETZ. Yes.

The CHAIRMAN. You assisted also in the preparation of the report?

Mr. SCHEETZ. Yes. All the red lines on the map show the small ditches in the Territory, and every ditch of them I ran myself.

The CHAIRMAN. Can you give the committee some further information as to the facilities for irrigating the valleys that you have marked?

Mr. SCHEETZ. I can give you no further information, I think, than is contained in the report which accompanies the map. That was intended to give all the information within our command.

The CHAIRMAN. That gives a good idea of the expense, or the approximate expense, does it?

Mr. SCHEETZ. Yes.

The CHAIRMAN. Have you in this vicinity places that have been irrigated?

Mr. SCHEETZ. Yes.

The CHAIRMAN. Has the irrigation been successful?

Mr. SCHEETZ. Yes. Just as successful as in the best parts of Colorado and Utah. More successful than the best valley lands on the Galatin. There is no soil on the earth that will produce more to the acre than the soil around here.

The CHAIRMAN. What class of crops are raised here?

Mr. SCHEETZ. Wheat, oats, rye, barley, and corn.

The CHAIRMAN. What fruits can you raise here?

Mr. SCHEETZ. Fruits are nearly untried here, except small fruits, such as gooseberries, strawberries, and so forth. There are a few apple trees that are bearing, but the country is new, and the people have not tried fruits much.

The CHAIRMAN. Do the small berries grow?

Mr. SCHEETZ. Yes, if watered.

The CHAIRMAN. You need irrigation to produce crops at all here, do you?

Mr. SCHEETZ. Yes; there has been one season since I have been here, since 1883, that an average crop would have grown if cultivated, and that was last year; one year in seven. That would not be one-third as large a crop as if they had sufficient water.

The CHAIRMAN. So that it would be improvident for one to attempt to farm here without irrigation?

Mr. SCHEETZ. Any one who will try it for a number of years will become bankrupt.

The CHAIRMAN. Has it been tried?

Mr. SCHEETZ. Yes.

The CHAIRMAN. With irrigation a sufficient crop could be raised?

Mr. SCHEETZ. Yes.

The CHAIRMAN. Are you familiar with Idaho and Colorado?

Mr. SCHEETZ. Yes; I am familiar with all the portion of the United States that is irrigated.

The CHAIRMAN. Would this land compare in productiveness with what you have seen elsewhere?

Mr. SCHEETZ. Yes.

The CHAIRMAN. What do you say of this climate?

Mr. SCHEETZ. I like it fully as well as California; I do not know that it is any better than Colorado. It gets somewhat colder than Colorado, but the cold is dry.

The CHAIRMAN. What is the average altitude?

Mr. SCHEETZ. The altitude here is higher than Colorado. The Marshall Pass and Cottonwood Pass and other passes are higher, and that accounts for our having a better climate here than they have in Colorado. We get the Japanese Current.

The CHAIRMAN. What kind of land is represented on your map?

Mr. SCHEETZ. In Custer County we estimate we have about three-

quarters of a million of acres. That, however, does not include a large part of the second bench. It was a low level.

The CHAIRMAN. As to the second bench, will you explain how that is?

Mr. SCHEETZ. What I call the second bench is the regular valley that comes over the very low valleys that are subject to overflow. The second bench is the one that comes in between that and the hills.

The CHAIRMAN. Have you run levels to ascertain whether the water can be taken onto that second bench?

Mr. SCHEETZ. Yes; by going farther up the stream. It is simply a question of labor.

The CHAIRMAN. How is the question of water in the river?

Mr. SCHEETZ. I think the Yellowstone has enough water to irrigate 5,000,000 acres of land without any reservoir system in the average season. This year the flow of the river has not been probably one-half what it ordinarily is.

The CHAIRMAN. How many million acres of land can be reached by the flow of the Yellowstone that would be level enough to irrigate?

Mr. SCHEETZ. Taking it from the mountain region to the mouth of the Yellowstone, I should estimate it at 5,000,000 acres. Of course there would be more land reached, but in getting from one bench to another there would be some land that would be of no value.

The CHAIRMAN. You would have to go on the second bench to get 5,000,000 acres?

Mr. SCHEETZ. Yes. On the second bench, the region from Glendive to Buford, it is lower than it is here. It is simply a step from the first bench to the second.

The CHAIRMAN. The extent of irrigation is very limited now, is it?

Mr. SCHEETZ. Yes. There is very little irrigation in this county. On the Rosebud, which is a small stream, the whole stream is used for irrigation.

The CHAIRMAN. With what success?

Mr. SCHEETZ. Very good success. No better anywhere.

The CHAIRMAN. About how much land has been brought into cultivation by it?

Mr. SCHEETZ. About 15,000 acres, I think, on the Rosebud. The valley extends about 15 miles.

The CHAIRMAN. Have you experimented with alfalfa to know whether it would make a good crop?

Mr. SCHEETZ. It is very successful here. There are about 6 tons to the acre of alfalfa grown here.

The CHAIRMAN. What is the quality of the alfalfa grown here?

Mr. SCHEETZ. About the same as that grown in Nevada and California.

The CHAIRMAN. Are there any other facts that you can state which will be of service to the committee?

Mr. SCHEETZ. I think you have covered the entire ground.

Senator REAGAN. In stating the amount of land irrigable in Custer County you confine yourself to the valley of the Yellowstone?

Mr. SCHEETZ. Largely to the valley of the Yellowstone, for the reason that on the Rosebud the valley is all used for irrigation. The ditches have already been taken out.

Senator REAGAN. What would be the irrigable land on the tributaries?

Mr. SCHEETZ. About 2,000,000 acres, I think, taking in the Little Missouri and the Box Elder. There is a system of reservoir sites at the head that would accommodate a large body of water. You can take

the Yellowstone alone, and the difference between low water and high water is very great. High water commences on the 15th of May and ends on the 15th of July, covering the irrigating season. The river rises 14 feet from extreme low water to extreme high water, so that there is a tremendous river there and an enormous amount of water that goes to waste.

The CHAIRMAN. You have traveled over the uplands, have you?

Mr. SCHEETZ. I think I have been over every foot of land in Custer county.

The CHAIRMAN. Are there any places in these uplands where a small area could be irrigated by storage?

Mr. SCHEETZ. There are large areas. The Big Horn and all such rivers head in the mountains. They have large benches, so that if storage was made there, it would cover a principality almost.

The CHAIRMAN. How much land would be reclaimed provided you inaugurated a reservoir system and reclaimed all the arable land in Custer County?

Mr. SCHEETZ. It would cover probably one-fifth of the whole area of the county. Custer County is about 100 miles wide and 200 miles long. But the larger portion of the land would be grazing land forever.

The CHAIRMAN. What kind of grazing land is there in Montana.

Mr. SCHEETZ. The very best.

The CHAIRMAN. Then your estimate is that in Custer County you can reclaim one-fifth of the land by irrigation?

Mr. SCHEETZ. Yes. By a system of reservoirs.

The CHAIRMAN. Is that true of the other counties along the Yellowstone?

Mr. SCHEETZ. It would hold good for Dawson County to a great extent and the county above here—Yellowstone. It runs largely in the mountains. As you go to the mountains, of course there is more mountainous land. We have a series of table-lands here, one above the other.

The CHAIRMAN. (Addressing Major Powell.) Should you like to ask this witness some questions?

Major POWELL. Just one. What experience have you had with artesian wells here?

Mr. SCHEETZ. There are probably fourteen artesian wells sunk in and around Miles City, and they will flow from 1 miner's inch to 4 miner's inches; I think Mr. Hoffman's well will probably flow 4 inches of water.

Senator REAGAN. That would be the equivalent of what?

Mr. SCHEETZ. They vary in depth from 180 to 550 feet. Mr. Hoffman's well is 166 feet. I had one completed a month ago that is 387 feet and runs 1 miner's inch. I should think Mr. Hoffman's well would give about 48 gallons to the minute.

Senator REAGAN. Is there any one that runs 17,000 gallons a day?

Mr. SCHEETZ. It would take me some time to figure up how these miner's inches work with relation to the number of gallons a day.

Senator REAGAN. How far is it back to the timber-land?

Mr. SCHEETZ. There are some scattering pines back of us.

Senator REAGAN. Is the timber pretty well preserved?

Mr. SCHEETZ. It is scattering pine and of medium size. None of it is large and none of it good. There is no first-class timber here.

Senator REAGAN. Are the forests being burned out in this vicinity?

Mr. SCHEETZ. No; we have not been troubled here much with forest fires. Our timber is not dense enough to carry forest fires very well.

Once in a while if a prairie catches on fire and it extends into the forests that burns it considerably.

STATEMENT OF E. P. H. HARRISON, COUNTY SURVEYOR OF CUSTER COUNTY.

The CHAIRMAN. You are county surveyor of this county, are you?

Mr. HARRISON. Yes. I have been county surveyor for the last six or eight months.

The CHAIRMAN. You made the report and map which we have here.

Mr. HARRISON. Yes.

The CHAIRMAN. Have you any information to give to the committee in addition to that which you have placed in your report?

Mr. HARRISON. I think not. I think my report covers all the ground.

The CHAIRMAN. Are you familiar with the county? Have you been over it yourself?

Mr. HARRISON. Not so thoroughly as Mr. Scheetz. I have been over quite a large part of it, however.

The CHAIRMAN. What do you say as to the practicability of storing water and irrigating a larger quantity of land than is indicated in this report?

Mr. HARRISON. I think it is thoroughly practicable. It is, certainly, for the second bench; that could not be reached much from the river.

The CHAIRMAN. What is the character of the land back of these benches, compared with the river land?

Mr. HARRISON. I think it is better.

The CHAIRMAN. What is the character of the soil?

Mr. HARRISON. It has more body, it is not so sandy; and I think it holds moisture better than the lands down in the valley.

The CHAIRMAN. Do you concur with Mr. Scheetz that 20 per cent. of this whole county can be reclaimed by irrigation?

Mr. HARRISON. Yes. I do not think that estimate too large at all. I think it will fully reach that.

The CHAIRMAN. You have not been troubled with forest fires?

Mr. HARRISON. No. The only fires we have been troubled with here are prairie fires. When the prairie fire gets into the timber it troubles us.

The CHAIRMAN. Have you timber for commercial purposes here?

Mr. HARRISON. No. Just enough for ranch purposes; and in some cases we have to go a great distance even for that.

The following is the report submitted by Mr. Harrison:

REPORT OF THE COUNTY SURVEYOR, CUSTER COUNTY, MONTANA.

OFFICE OF COUNTY SURVEYOR,
Miles City, Custer County, Mont., July 8, 1889.

To the honorable The Board of County Commissioners of Custer County:

GENTLEMEN: In accordance with your instruction of July 1, 1889, to prepare a map of Custer County, showing the amount of valley lands at present under irrigation, and also all lands that can be brought under irrigation in this county, and also a report showing the available amount of water in the various streams and all other data pertaining to this subject, said map and report to be used by the Senatorial Committee and asked for by them in their letter of June 18, 1889, from Mr. Hinton, the engineer of the committee, I submit herewith the map and following report:

Custer County is watered by the Yellowstone River and its various tributaries, and also by the tributaries of the Missouri and Little Missouri Rivers and Beaver Creek.

As the Yellowstone is the largest stream, covering the greatest amount of valley

land, I will name it as being the most desirable for Government aid in the construction of a system of irrigating canals. The valleys of the Yellowstone are ordinarily from 20 to 50 miles long and from 1 to 4 miles wide, lying alternately on each side of the river. The soil is generally a sandy loam, and wherever irrigation has been tried crops of wheat, oats, barley, corn, potatoes, alfalfa, and all other sorts of garden truck have been raised that are not excelled by the production of the famous and fertile valleys of the Gallatin, Madison, and Jefferson.

The valleys of the Yellowstone in this county comprise about 384,000 acres, all of which could be irrigated, still leaving half its water in the stream, besides what would get back to its stream from seepage and the waste-ditches.

These valleys have now a population of 1,000 people, and would, if brought under irrigation, soon support 30,000.

The Yellowstone passes through Custer County for a distance of 200 miles and carries about 906,000 cubic or miner's inches of water at its ordinary stages, and during the months of May, June, and July, the time when water for irrigating is most necessary, its volume is increased fully one-fourth.

A ditch or canal has been taken from the river on the north side, opposite the mouth of the Big Horn River, to cover what is known as the Pease Bottom. This ditch is only partially completed, but the results obtained have been most satisfactory. This ditch could be so enlarged and constructed that after covering the Pease Bottom it could be carried around the face of the bluffs in flumes, and be used for watering the valleys below and on the same side of the river. These valleys embrace about 100,000 acres.

On the south side of the river, at a point below Guy's Bluff, a canal could be constructed covering the large valley on which are the stations of Myers, Sanders, Howard, and Forsyth, on the Northern Pacific Railway, its length being about 30 miles. No heavy fluming would be necessary, as the streams coming into the Yellowstone from the south side between these points are all small. This canal would cover about 57,600 acres of land. A small tract of land is now under irrigation on this valley, its water being gotten from Reservation Creek.

The largest valley in any one body lies from the foot of the Buffalo Rapids (which have a good fall) down the river on the south side for 50 miles, and varies in width from 1 to 4 miles. A large ditch could be constructed covering this entire area, amounting to 80,000 acres. It would of necessity be expensive, as the work at the rapids would have to be done in solid masonry, and the canal carried over Powder River either by an aqueduct or a tunnel under the bed of the stream. In other respects its work would be ordinary earth-work. This would reclaim a large area of the finest land in Montana, at present used only for grazing purposes.

Powder River, the next longest in the county, flows from the Montana-Wyoming boundary line, a distance of about 170 miles, to its mouth, where it empties into the Yellowstone River. The valleys covered by it will average $1\frac{1}{2}$ miles in width, and embrace about 163,200 acres, which is good soil and very productive where water has been gotten on the lands.

Tongue River crosses the Montana-Wyoming boundary about 150 miles from its junction with the Yellowstone at Miles City, and flows through valleys averaging 1 mile in width, embracing about 96,000 acres. This valley is capable of producing crops equal to any that can be raised in the Territory where water can be put on them, as has been demonstrated on the river near the Wyoming line.

The Miles City Irrigating Ditch Company have in course of construction and nearly completed a canal that will cover about 9,000 acres of Tongue River Valley, and be then carried to the Yellowstone Valley lying east of Miles City, where it will be used on about 21,000 acres.

In connection with the construction of this canal, Tongue River has been dammed at a cost of \$50,000. The heavy cost of ditch-construction on the streams is at the point of departure from the bed of its stream, the earth-work being comparatively light.

Rosebud Creek has its source in Custer County, and flows northeast, to its confluence with the Yellowstone River, for a distance of about 100 miles. This valley averages about one-half mile in width on each side of the stream, and embraces about 64,000 acres of land. The supply of water in this stream is limited, but for which fact the fertile valley would be all under cultivation, as the water can be taken out from the bed of the stream at a comparatively small cost.

Little Missouri is in the southeastern portion of the county, and flows through it for a distance of 65 miles, where it crosses into Dakota. This valley embraces about 112,000 acres of land.

Little Powder River, a tributary of Powder River, flows through the county for a distance of about 30 miles. Its valley averages about a half mile in width on each side of the river, and embraces about 19,200 acres of land.

In addition to the above-named streams there are numerous smaller ones, which in most cases have had all the available water taken out into ditches. A noticeable fact

about these small streams is, that the water is often in pools, sometimes flowing for a quarter of a mile, when it will sink and not rise for frequently 3 and 4 miles; a fact which makes it unavailable for irrigation.

The season of the year when the largest volume of water would be consumed is during the months of May, June, and July, this being the time when the crops would be growing, but for fall and winter pasture it can be used advantageously as late as October.

Regarding the amount of water necessary for the land, close observation and the experience of all who have given attention to the matter is, that 1 cubic or miner's inch of water is sufficient for the irrigation of 1 acre.

The valley lands of Custer County contain to-day fully 125,000 acres of land that have been virtually abandoned after spending years of toil and thousands of dollars in a vain attempt to successfully farm without irrigation.

The following table gives the estimated amount of water in the streams, the number of acres of valley land, and the number of inches of water used at the present time:

Name of River.	Water in stream.	Water used for irrigation.	Valley land.	Land under irrigation.
	<i>Inches.</i>	<i>Inches.</i>	<i>Acres.</i>	<i>Acres.</i>
Yellowstone	906,000	6,000	384,000	4,000
Tongue	77,200	10,200	96,000	10,200
Powder	46,920	1,920	163,200	1,920
Little Powder	4,320	320	19,200	320
Rosebud	4,770	3,020	64,000	2,020
Otter	2,900	2,400	9,600	2,400
Pumpkin	410	160	38,000	160
Muddy	720	320	4,800	320
Lame Deer	500	.....	5,000	.....
Beaver	400	160	40,000	160
Terry	400	400	.....	400
Little Beaver	380	380	5,000	380
Emmells	500	240	10,000	240
Reservation	320	320	4,800	320
Hanging Woman	240	240	10,000	240
Little Missouri	5,000	.....	112,000	.....
Total	1,050,980	26,080	965,000	26,080

Respectfully submitted.

E. P. H. HARRISON,
County Surveyor.

Approved by the Board of County Commissioners, July 8, 1889.

GEO. W. ALLERTON,
Chairman of the Board.

STATEMENT OF GEORGE B. MILBURN, OF MILES CITY, CUSTER COUNTY.

The CHAIRMAN. How long have you resided in Miles City?

Mr. MILBURN. Most of the time since March, 1883.

The CHAIRMAN. Have you made yourself familiar with this county?

Mr. MILBURN. I have traveled over much of it; partly in the Crow Reservation and the country south of here on Tongue River and on the Rosebud and Powder Rivers. I have been north as far as Wolf Point, and west as far as the western limit nearly on the railroad.

The CHAIRMAN. In your travels have you paid attention to the subject of reclaiming the land by irrigation?

Mr. MILBURN. I have given that attention to it that any other citizen would who was interested in the welfare of the country. I have no scientific knowledge in connection with it.

The CHAIRMAN. Have you observed the section of country where irrigation is practiced?

Mr. MILBURN. Yes.

The CHAIRMAN. What is the result of irrigation as far as you have observed ?

Mr. MILBURN. The result is extraordinary. The crops resulting are astonishing to a person who has been accustomed to farming in the East in the ordinary way.

The CHAIRMAN. What portion of the East did you belong to ?

Mr. MILBURN. I was born in Washington City. I can compare the results here with those I have seen in Maryland and Virginia, particularly.

The CHAIRMAN. How will an acre of land irrigated here compare in productiveness with the best acre of land you have ever seen in Virginia or Maryland ?

Mr. MILBURN. I should say it would produce five times as much, year in and year out, for a term of ten years.

The CHAIRMAN. That one acre of land here would, if cultivated for a continuous period of ten years, produce five times as much as an acre of the best land in Maryland or Virginia with which you are acquainted ?

Mr. MILBURN. I believe it would.

The CHAIRMAN. Has there ever been a failure of the crops here where they have been irrigated ?

Mr. MILBURN. Never to my knowledge. Almost always, when there is not irrigation, the crop will fail. The crops obtained here in a year of phenomenal rains will not compare in quality or quantity with those which would be produced by irrigation.

The CHAIRMAN. Suppose we had proper surveys, which would designate the land that could be irrigated and the means whereby it could be irrigated, and suppose we had land laws that would enable people to obtain the land and at the same time not lead to monopoly, is the country so situated that private enterprise would develop it rapidly ?

Mr. MILBURN. There is no doubt whatever of that. Inquirers are coming into the country all the time, sent in here by people who desire to find good agricultural lands.

The CHAIRMAN. Have you reflected on the changes necessary in the land laws to facilitate irrigation ?

Mr. MILBURN. I have not.

The CHAIRMAN. You have no suggestions to make in regard to that ?

Mr. MILBURN. I have not considered that matter at all.

The CHAIRMAN. Have you considered the matter of protecting what growing timber you have here ?

Mr. MILBURN. Yes.

The CHAIRMAN. What is your idea as to how the timber should be protected ?

Mr. MILBURN. I think the only measure necessary is to send to the penitentiary the men who set fire to the forests by carelessness. In other words, enforce the laws already on the statute-books.

The CHAIRMAN. For that purpose would you not want some responsible citizen to look after it ?

Mr. MILBURN. That is exactly what is wanted.

The CHAIRMAN. There is no necessity for having any secret agents for that purpose, is there ?

Mr. MILBURN. None whatever.

STATEMENT OF ABRAM HALL, RECEIVER OF LAND OFFICE, MILES CITY, CUSTER COUNTY.

The CHAIRMAN. What is the extent of your land district?

Mr. HALL. It takes in all of Custer County and Dawson County, the eastern part of Yellowstone County and Meagher County.

The CHAIRMAN. About how long would it be from north to south and east to west?

Mr. HALL. It is all the eastern part of Montana, as far west as the twenty-eighth township. There are about thirty-two townships in it.

The CHAIRMAN. Thirty-two, from east to west?

Mr. HALL. Yes. They are numbered from west to east.

The CHAIRMAN. How much land has been disposed of in that area?

Mr. HALL. There have been 565 homestead entries made in this office since the establishment of the office in 1880 or 1881, and there have been 420 pre-emption filings made.

The CHAIRMAN. Then the railroad lands are to be deducted?

Mr. HALL. Yes sir.

The CHAIRMAN. Have you ever figured up how much remains of the public land now undisposed of, either by railroad or otherwise?

Mr. HALL. I have not figured it up, but there is a very small per cent. of the land yet taken.

The CHAIRMAN. Either by the railroad or by public entries?

Mr. HALL. By either.

The CHAIRMAN. The great majority of it then is public land?

Mr. HALL. Yes; but there is very little of it in comparison with that which has been taken or disposed of by the Northern Pacific Railroad.

The CHAIRMAN. Have you traveled over it much to see the character of the soil?

Mr. HALL. I have, considerably.

The CHAIRMAN. Of course we take it for granted that it is not fit for cultivation, as a rule, without irrigation.

Mr. HALL. That is correct.

The CHAIRMAN. In passing over it have you had in mind the question of irrigating it?

Mr. HALL. Yes.

The CHAIRMAN. Did you see the facilities for irrigating it?

Mr. HALL. It appears to me the facilities are good. The Montana streams all afford an abundance of water at the very time of the year when it is most needed; that is in June and July.

The CHAIRMAN. Does not a large amount of water run down the streams at times when it is not needed?

Mr. HALL. Yes.

The CHAIRMAN. Have you observed the contour of the country and the source of the streams with a view of seeing where water could be stored and held back?

Mr. HALL. No; I cannot say that I have.

The CHAIRMAN. So that from your experience you would not be able to make any estimate of what may be done in that respect?

Mr. HALL. No.

Senator REAGAN. What portion of the land in your district would you consider available for cultivation under irrigation?

Mr. HALL. I could not state really. I should think that what has been stated is a fair estimate, namely, twenty per cent., if not more.

The CHAIRMAN. You think that perhaps more than twenty per cent. can be ?

Mr. HALL. There is at least that much that can be irrigated. I should think that would be a fair percentage.

Senator REAGAN. That is, in your district.

Mr. HALL. Yes. The valleys below here have been mostly taken up under the homestead and pre-emption filings. But a great many of them—in fact most of them—have been abandoned for the present. They were taken in the first place by, perhaps, adventurers or speculators. I think there have been about two crops of settlers in this country, and there is a third coming in. The valleys below here are only sparsely settled. I know that if there could be a system of irrigation projected the valleys would be very rapidly settled up. Every legal subdivision would be immediately available.

The CHAIRMAN. Are the homestead and pre-emption laws applicable to this section of the country ?

Mr. HALL. Yes.

The CHAIRMAN. That is, can a homesteader come here and make a home without having some combination or arrangement whereby the water can be brought in ? Of course he can take the land, but can he stand it here as a rule ?

Mr. HALL. I shouldn't think a man could make a living at farming independent of any stock interest.

The CHAIRMAN. Agricultural pursuits, then, without irrigation, are impracticable here ?

Mr. HALL. To a great extent, yes. We have a few farmers that have made a living, but very few. Usually they have combined farming with stock-raising.

The CHAIRMAN. What modification in the homestead law would enable people to make homes here ? Have you given thought to that subject ?

Mr. HALL. I don't know that I have. I should think the present homestead system would be successful to a great extent, though perhaps a modification of it might be made.

The CHAIRMAN. What will people do on this desert land while they are getting their homes made and their ditches ? Can they do much until they get their ditches in ?

Mr. HALL. No ; they can not.

The CHAIRMAN. Can a single homesteader as a rule enter land, except where he can find small fertile places ?

Mr. HALL. No ; I think not, without a system of irrigation.

STATEMENT OF WILLIAM COURTNEY, OF MILES CITY, CUSTER COUNTY.

The CHAIRMAN. What is your occupation ?

Mr. COURTNEY. I am a live-stock broker.

The CHAIRMAN. How long have you resided in Miles City ?

Mr. COURTNEY. Eight years.

The CHAIRMAN. Are you familiar with the surrounding country ?

Mr. COURTNEY. To some extent.

The CHAIRMAN. Have you traveled over it ?

Mr. COURTNEY. Yes ; in the early days I traveled over it. I have been for twenty-three years a resident of Montana. I was over the country a good deal before there were any settlements here.

The CHAIRMAN. Have you observed the effects of irrigation and the facilities therefor in this part of the country?

Mr. COURTNEY. Not to any great extent, but I have partially.

The CHAIRMAN. You have seen the results of irrigation?

Mr. COURTNEY. Yes.

The CHAIRMAN. What are those results in this country?

Mr. COURTNEY. They are simply astonishing.

The CHAIRMAN. What part of the country do you come from?

Mr. COURTNEY. From the State of New York. I was born in England, but have been thirty-five years in America.

The CHAIRMAN. Do you know something about farming in England?

Mr. COURTNEY. Yes.

The CHAIRMAN. And in New York?

Mr. COURTNEY. Yes. I was nine years at an Indian Agency in the West, Fort Berthold. I saw a good deal of farming at that point, but they had no irrigation there. They found the soil much more fertile on the bench lands than on the bottom lands, and they raised better crops on the bench land.

The CHAIRMAN. Have you observed the crops of this county, that have been produced by irrigation?

Mr. COURTNEY. Yes.

The CHAIRMAN. Supposing you should take a term of ten years, how would you compare the land here that is irrigated with land in New York with which you are familiar?

Mr. COURTNEY. I think that irrigation would produce more than five times the ordinary crop.

The CHAIRMAN. Irrigation here would produce more than five times the ordinary crop, on good land? Is that your idea?

Mr. COURTNEY. Yes.

The CHAIRMAN. I ventured in a recent article to say that irrigation would more than double a crop and I was much criticised by a number of newspapers for my "exaggeration."

Mr. COURTNEY. That is by no means an exaggeration. I have an artesian well in operation at my home here in Miles City.

The CHAIRMAN. How deep is that well?

Mr. COURTNEY. Five hundred and thirty-five feet.

The CHAIRMAN. Through what material did you go to reach it?

Mr. COURTNEY. I think through sandstone.

The CHAIRMAN. What did you strike immediately above the water?

Mr. COURTNEY. Sandstone, I think.

The CHAIRMAN. Was it hard?

Mr. COURTNEY. Yes; it took some time to bore through it.

The CHAIRMAN. What did you find the water in?

Mr. COURTNEY. In gravel, I think. We got a very good flow, I think 100 barrels in twenty-four hours.

The CHAIRMAN. What is the size of the well?

Mr. COURTNEY. It is a 4-inch well.

The CHAIRMAN. Have there been many wells sunk in this town?

Mr. COURTNEY. About fourteen altogether.

The CHAIRMAN. Has the increase in quantity in the wells affected the flow of the water?

Mr. COURTNEY. No.

The CHAIRMAN. The other wells flow about the same quantity as yours?

Mr. COURTNEY. Yes.

Senator REAGAN. Are the wells of about the same depth?

Mr. COURTNEY. They vary in depth very much.

The CHAIRMAN. Then you have not struck any uniform stratum from which the water comes?

Mr. COURTNEY. No. On the other side of the Yellowstone River, at about an elevation of 600 feet above the Yellowstone, there is a man farming who dug down 50 feet and got good water. His crops were then looking well.

Senator REAGAN. Does he irrigate from his well?

Mr. COURTNEY. No. He has had no means of irrigating, but at 55 feet from the surface he got good water.

Senator REAGAN. How is the water here in this city?

Mr. COURTNEY. The character of the water is very good. I went down 18 feet for a well for drinking purposes, and got a good flow, winter and summer. We use it at my home.

Senator REAGAN. Is the artesian water good for drinking purposes?

Mr. COURTNEY. I do not like to use it for drinking purposes, but it is good water for irrigating and for washing. I use it on my lawn and in my laundry and for cooking.

The CHAIRMAN. What kind of a grazing country is this?

Mr. COURTNEY. We have the best grazing land in the Northwest, without exception. I have been all over Montana, and I consider we have got decidedly the best grazing lands in the Northwest.

Senator REAGAN. If all the land that was susceptible of irrigation here was devoted to agriculture and the raising of grasses and so on, and the balance was used for pasturage, what kind of a country would you have up here?

Mr. COURTNEY. A splendid country. Our valley would be full of industrious farmers if irrigation were made extensive. As it is, our county supports, in round numbers, about 200,000 head of cattle, and gives pasturage for that number. There are 36,000 square miles in Custer County. In ordinary seasons we find an abundance of pasturage, and cattle, I think, are fatter, in better order, and mature earlier in this county than in any other place I know of in the Northwest. I will simply give you an illustration of that. In 1886 I sold about 900 head of three-year-old steers that were raised in northern Wyoming, and were driven up here to Montana. We had a hard winter in 1886-'87. In 1888 those two-year-olds were four-year-olds, and the new owners gathered about 600 head of them and took them to Chicago and sold them for \$52.50 a head. In the same year that these cattle were sold a lot of Wyoming cattle were marketed, and the Wyoming men who marketed the same class of steers, exactly, could get for them only \$39 a head. That shows the difference between the cattle raised here and the cattle raised in Wyoming.

The CHAIRMAN. Wyoming is a pretty good stock country?

Mr. COURTNEY. Yes. We have also here, I may say, inexhaustible coal-fields. The whole country is spread over with vast coal-fields. In some places the veins crop out 7 feet in thickness. That is a very important point for settlers coming here. They can get fuel cheap. We can deliver good lignite coal at our homes here at an average of \$2 a ton, and there are very extensive fields of it.

The CHAIRMAN. That is a great consideration for settlers.

Mr. COURTNEY. Yes; a most important consideration.

The CHAIRMAN. Does that coal extend all over the county?

Mr. COURTNEY. Yes,

The CHAIRMAN. Is it near the surface and easily obtainable?

Mr. COURTNEY. Yes. There are numbers of men here that hardly mine at all, but scratch the ground and get their supply of coal.

STATEMENT OF L. A. HUFFMAN, OF MILES CITY, CUSTER COUNTY.

The CHAIRMAN. How long have you resided in Miles City?

Mr. HUFFMAN. About ten years; in the neighborhood a little longer.

The CHAIRMAN. Have you traveled over this section of country?

Mr. HUFFMAN. I have.

The CHAIRMAN. Are you familiar with its topography?

Mr. HUFFMAN. Yes.

The CHAIRMAN. Have you looked the country over with a view to irrigation—storing water, diverting water from the rivers, etc.?

Mr. HUFFMAN. Yes, I have.

The CHAIRMAN. Can you describe the general topography of the country and what its advantages are for obtaining water?

Mr. HUFFMAN. Not being an engineer, I have not examined the country scientifically.

The CHAIRMAN. You have examined it as a practical man?

Mr. HUFFMAN. Yes; I have. It seems to me there is no country better adapted, naturally, for that purpose, taking into consideration the fall of the streams and the amount of water they carry in the spring-time from the melting of the ice and snow. In June the streams have a large volume of water in them, and there are basins where a large number of reservoirs could be built for storing water. Since I read of your sayings in Congress and of the prospective work of this committee, it has seemed to me that here in the Yellowstone Valley more than in any other place I know of, considering the amount of land that could be reclaimed, the water could be more easily stored. If you will look out of the window you will see low hills, in which there are streams, and back of these streams you will find basins with a gulch leading out of them 2 miles long that might be made into reservoirs; and this little Tongue River goes over this bank.

The CHAIRMAN. You have no means of estimating what proportion of the country might be brought under irrigation by storage? You have not figured on that?

Mr. HUFFMAN. No, I have not figured on it; but I have it in my mind as to the great quantity of water that might be stored. The water that goes down these rivers would affect an enormous amount of land.

The CHAIRMAN. Then you agree with others who have testified in regard to irrigation?

Mr. HUFFMAN. Yes.

The CHAIRMAN. In what State did you live originally?

Mr. HUFFMAN. Iowa.

The CHAIRMAN. What do you say in regard to the productive capacity of irrigated land here as compared with that of Iowa? During a period of ten years, what would be the results?

Mr. HUFFMAN. There can be no comparison. We can raise more of the stuff I have seen planted here, beginning with garden vegetables. I do not know but that I will except corn. But of all that I have seen experimented with here, we can raise double what they can in Iowa.

The CHAIRMAN. You can have a sure crop here every year under irrigation?

Mr. HUFFMAN. Yes. We would escape one difficulty that they have there—our crops would not be destroyed at the time of harvest. We can rely on a dry harvest for the grain, and that they can not do in Iowa.

The CHAIRMAN. And you would have your own time to plant?

Mr. HUFFMAN. Yes.

The CHAIRMAN. Take a term of years in both countries; how would you compare an acre of land here with an acre in Iowa?

Mr. HUFFMAN. It would be a good deal better in all respects here, and would produce at least double. I consider double the crop a conservative estimate—especially hay—all forage.

The CHAIRMAN. Have you seen irrigation practiced long enough to observe anything about the effect of fertilizing land by that means? You have not looked into that.

Mr. HUFFMAN. We all know that a piece of prairie that is utterly worthless produces hay when irrigated, good blue stump hay, very nutritious. That we do not find anywhere else.

The CHAIRMAN. I think Major Powell can tell you something about the fertilizing effects of water.

Mr. HUFFMAN. Yes, I have read his writings with interest.

Director POWELL. To what extent back in the hills 3, 6, 8, and 10 miles can the storm waters be stored? What are the facilities up on the second, third, and fourth benches for storing storm waters?

Mr. HUFFMAN. They are vast. But as to the expense, it takes an engineer to estimate that. And, as I stated before, this country, from its topography, its contour, is better adapted to that sort of irrigation than any other country I have been in. I can not conceive of a better, when you take into consideration the nearness of water to the land to be supplied. You can go into the mountain ranges and find larger places for reservoirs for storing water, but that would be too far away from where you would want to use the water.

STATEMENT OF S. GORDON, OF MILES CITY, CUSTER COUNTY.

The CHAIRMAN. What is your occupation?

Mr. GORDON. Editor of the Daily Yellowstone Journal.

The CHAIRMAN. How long have you resided here?

Mr. GORDON. Nine years.

The CHAIRMAN. Have you traveled over this country?

Mr. GORDON. To some extent, yes.

The CHAIRMAN. Has your attention been called to the subject of irrigation and its effect?

Mr. GORDON. Yes.

The CHAIRMAN. What do you say in regard to its effect upon the land?

Mr. GORDON. Its effect is miraculous.

The CHAIRMAN. From what State were you originally?

Mr. GORDON. New York city, originally.

The CHAIRMAN. Were you familiar with the farms outside of the city?

Mr. GORDON. No; I lived in the city all the time; I have lived in Minnesota, too.

The CHAIRMAN. Do you know anything about farming land there?

Mr. GORDON. Yes.

The CHAIRMAN. What do you say in regard to the land there—its productive capacity for ten years as compared with land here?

Mr. GORDON. This land here has an advantage over the land in Minnesota.

The CHAIRMAN. What would be the relative capacity for production for a period of ten years?

Mr. GORDON. I think the wheat crop there is 10 or 12 bushels to the acre. I think here on irrigated land it would be 50 bushels to the acre,

I have at my office a sheaf of wheat that I ought to have brought here with me. It was produced on irrigated land.

The CHAIRMAN. Then, with your land, you have the other advantages of producing all sorts of crops.

Mr. GORDON. Everything that has been planted here grows spontaneously if it has water.

The CHAIRMAN. You have not had a chance to try whether fruits will grow here?

Mr. GORDON. Berries have been tried here; I do not think the larger fruits have been. There are some places where they have crab-apple trees.

The CHAIRMAN. Have you looked over the topography of the country with a view to seeing whether irrigation might be practiced here?

Mr. GORDON. I have, but I do not think my opinion would be worth much on that subject. I have no practical ideas on the subject.

The CHAIRMAN. Except what you have gained from others?

Mr. GORDON. Just what I have heard from others. What you have heard here to-day from other gentlemen would be what I would say.

The CHAIRMAN. What we have heard stated to-day is about the general judgment of the people familiar with the subject?

Mr. GORDON. That is the way we talk all the time.

The CHAIRMAN. What do you say as to the climate in this country?

Mr. GORDON. It is the finest that I have ever experienced. I do not know whether any other gentleman has touched upon the subject or not, but for the purposes of agriculture we have from six weeks to eight weeks longer season for crops than in any other place, comparing it particularly with Minnesota, where I have had most experience. The spring here commences earlier and the fall later. Our growing season commences about the 15th of March and ends in October.

STATEMENT OF J. W. STRIVELL, OF MILES CITY.

The CHAIRMAN. How long have you resided in Miles City, Custer County?

Mr. STRIVELL. Ten years.

The CHAIRMAN. Are you familiar with this section of Montana?

Mr. STRIVELL. Yes.

The CHAIRMAN. Have you traveled over it considerably?

Mr. STRIVELL. Yes; extensively.

The CHAIRMAN. What is your occupation?

Mr. STRIVELL. I am a practicing lawyer and interested in stock.

The CHAIRMAN. And those occupations have called you over the country?

Mr. STRIVELL. Yes.

The CHAIRMAN. Has your attention been called to the subject of irrigation?

Mr. STRIVELL. Yes, often. My attention has been called to it as the only remedy for this country—its salvation, if it is to have any.

The CHAIRMAN. Agricultural pursuits without irrigation would be impracticable?

Mr. STRIVELL. Wholly so.

The CHAIRMAN. What are the facilities for agriculture with irrigation?

Mr. STRIVELL. Very extensive. The effort to cultivate land without irrigation is a failure. I agree with one of the gentlemen who was on

the stand in the early part of this examination, that it is only a question of time when it would break any man; but with irrigation, the reverse is true. I think this would be as successful a country with irrigation as there is on the globe. I have seen irrigation extensively practiced in Arizona. I have been over the lands in the Salt River and the Gila River Valleys.

The CHAIRMAN. Those valleys are fine illustrations of the effects of irrigation?

Mr. STRIVELL. Yes. I know they would be worth nothing without irrigation, and I think this country would be equally successful.

The CHAIRMAN. As the Salt River Valley?

Mr. STRIVELL. Yes. I think it would produce as well as the Salt River Valley. I have raised alfalfa, and I see no difference between it and the alfalfa in the Salt River Valley in Arizona. I have seen alfalfa in Colorado, and where we irrigate I think our alfalfa is equal to that in either of those places.

The CHAIRMAN. How many tons can you cut in a season, where it is properly cultivated—on irrigated land?

Mr. STRIVELL. Of course they tell fabulous tales in the Salt River Valley about cutting 10 tons to the acre in a season. I have alfalfa not irrigated, except as it gets moisture from a lake. This alfalfa is 10 feet from that lake, and it has all the effects that could be derived from irrigation, and I have cut it three times up to this date. I use it for horse feed. But I would not put the amount so high as they do in Arizona. I am convinced that with irrigation we could produce 6 tons to the acre.

The CHAIRMAN. How is your land with regard to variety of crops?

Mr. STRIVELL. All that you could produce in Illinois or the Mississippi Valley. I agree with Mr. Huffman that the corn would not be the kind of corn that is raised in the Mississippi Valley—so extensively raised there—though it might be. But all other crops that could be raised anywhere else in this northern latitude could be raised here.

The CHAIRMAN. From what State were you originally?

Mr. STRIVELL. New York, originally. I lived twenty-four years in Illinois.

The CHAIRMAN. Then you are more familiar with Illinois?

Mr. STRIVELL. I am perfectly familiar with that State.

The CHAIRMAN. What would you say as to all-around crops for a period of years? What would be the comparison between the land here and the average best land in Illinois?

Mr. STRIVELL. The estimate for Illinois is one successful crop in three years; the others a diminished crop. We could raise with irrigation a successful crop every year. Of course I do not mean that we might not in localities be subject to a storm or something of that kind—hail, perhaps, in a limited way. Though we are not in the hail belt we do sometimes have it. But you could safely count on a successful crop every year.

The CHAIRMAN. Do you know to what extent the water that is put upon the land fertilizes it?

Mr. STRIVELL. I think that depends on the water. If the water has a large amount of sediment in it, as it has in the Salt River Valley, it would. The Nile is an example of that. But I have no knowledge except of the water from the wells. I do not know that that has any fertilizing quality.

The CHAIRMAN. I do not suppose that it has any more than rain-water.

Mr. STRIVELL. No; but the water that comes down filled with sediment has a fertilizing quality to a large extent.

The CHAIRMAN. Suppose you were to catch the storm waters in reservoirs, how would that be?

Mr. STRIVELL. My opinion of the fertilizing quality of water is that it comes from the sediment carried in the water, and that would, if retained in a reservoir a long time, settle on the bottom.

The CHAIRMAN. I think Major Powell can give you some information on that head.

Director POWELL. Water stored in a pond from year to year becomes filled with microscopic plants, microscopic animals and organisms, and for that reason is valuable as a fertilizer.

Mr. STRIVELL. I have no doubt that is true.

The CHAIRMAN. Have you looked over the country with the view of ascertaining the extent to which you might practice irrigation here?

Mr. STRIVELL. Yes; I understand the formation of the country very well.

The CHAIRMAN. What are the opportunities for storing the water in ponds?

Mr. STRIVELL. Almost limitless. The country is made up of hills and gorges. A valley that you would at the mouth as you pass it scarcely suspect amounted to anything, yet when you get into it you would find it to be sometimes 25 to 35 miles long. I do not think I exaggerate. At the head of such a valley as that you could find a place where water could be stored for that whole lateral valley.

The CHAIRMAN. Would a system of surveys showing how that could be done and marking out the places be useful here?

Mr. STRIVELL. It would be almost invaluable. I think the great possibilities of this country are to be developed in the Rocky Mountains and arid regions.

The CHAIRMAN. You are practicing law here. Have you considered what changes should be made in our land laws to adapt them to our arid region?

Mr. STRIVELL. I have not, except this: It would require a combination of capital to make irrigation successful—to make ditches of sufficient length and capacity to irrigate the farms. You will find an illustration of that in a fine valley above here, known as the Pease Bottom. They have a ditch there which is an eminent success. But it takes a combination of capital. You can find land so low that you can utilize a basin. A basin might irrigate the whole valley, the people there being joint tenants.

The CHAIRMAN.—At the last session Congress reserved these reservoir sites, and when the surveys are made they will be used in common by the people who irrigate from them.

Mr. STRIVELL. That is all that is necessary.

The CHAIRMAN. Do the people need any modification of the laws to enable them to combine and construct the works when they enter the lands?

Mr. STRIVELL. The matter of water is now receiving a large amount of attention from our constitutional convention which is now in session at Helena. I think that proprietary rights by an individual should be done away with, and I think they will be in our constitution. That is to say, our constitution will prohibit one individual from monopolizing the water.

The CHAIRMAN. You do not want the land divorced from the water?

Mr. STRIVELL. No, it should be with it.

The CHAIRMAN. Where the water is the principal and the land an incident, you do not want them separated?

Mr. STRIVELL. No.

The CHAIRMAN. Probably your convention has adopted the Colorado provision. The matter of arranging that is not difficult; it can be accomplished.

Mr. STRIVELL. I think so.

Senator REAGAN. What is the character of the soil in these valleys?

Mr. STRIVELL. The Yellowstone and Tongue River Valleys?

Senator REAGAN. Yes; where reservoirs could be made. What is the character of the soil there?

Mr. STRIVELL. If you will allow me, I will give you the opinion of another. The first time I came to this country I was with a Mr. Ames, of Illinois, a nephew of Bishop Ames. He said that the soil was better than the soil of Illinois.

Senator REAGAN. My question related to the character of the soil for holding water.

Mr. STRIVELL. As to whether it is impervious to water?

Senator REAGAN. Yes.

Mr. STRIVELL. It is largely impervious to water.

Senator REAGAN. How would that be in the valleys?

Mr. STRIVELL. You can make a ridge by damming, etc., elevate your water range and make your trough for a long distance out of the soil, and that will carry your water thoroughly almost any distance and take it off in lateral lines. It is perfect in regard to that.

Adjourned.

ON TRAIN AT BILLINGS, MONTANA, *August 7, 1889.*

The committee met on call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF H. W. ROWLEY, OF BILLINGS.

The CHAIRMAN. How long have you resided at Billings?

Mr. ROWLEY. Since 1882.

The CHAIRMAN. What is your occupation?

Mr. ROWLEY. I am a civil engineer.

The CHAIRMAN. Did you make the map which is before us, marked B. S. B., No. 3?

Mr. ROWLEY. Yes.

The CHAIRMAN. What does it represent?

Mr. ROWLEY. The valley of the Yellowstone, from Billings west, 35 miles.

The CHAIRMAN. And what else?

Mr. ROWLEY. And the country immediately tributary thereto. It is all the valley of the Yellowstone.

The CHAIRMAN. Does it represent anything else?

Mr. ROWLEY. It is a map of the valley. The red lines [indicating] show the ditches that have been constructed. The upper line [indicating] is the larger ditch, the one first constructed.

The CHAIRMAN. Does that include the larger portion of the land?

Mr. ROWLEY. Yes; that takes in the whole country. The others are parallel ditches, taking in that land down to the river.

The CHAIRMAN. What length is that?

Mr. ROWLEY. Thirty-five miles.

The CHAIRMAN. What size in width?

Mr. ROWLEY. Twenty-four feet at the bottom and 30 at the top.

The CHAIRMAN. How much land does it cover?

Mr. ROWLEY. It covers about 65,000 acres. It is not of sufficient size to irrigate that much.

The CHAIRMAN. Is there ample water in that river at that point to irrigate the land?

Mr. ROWLEY. Yes.

The CHAIRMAN. How much land is irrigated by that ditch?

Mr. ROWLEY. Five thousand acres at the present time.

The CHAIRMAN. Are the other ditches completed—those that we see marked here?

Mr. ROWLEY. They are nearly completed. Most of them are completed. I do not know but all of them are now completed. Some of them were constructed this year.

The CHAIRMAN. Have any of them been used to irrigate land?

Mr. ROWLEY. Yes; the ditch marked "Cañon Ditch" has been in operation two years.

The CHAIRMAN. What crop do you raise on the lands that are irrigated by these ditches.

Mr. ROWLEY. Wheat, oats, and some corn, alfalfa and millet and small fruits. I do not know all the crops; there is a great variety in a small way.

The CHAIRMAN. With what success have you produced crops with irrigation?

Mr. ROWLEY. We have very good success. The land here that is watered seems to be very productive.

The CHAIRMAN. From what State were you originally?

Mr. ROWLEY. I was born in New York; I have lived in Minnesota most of my life.

The CHAIRMAN. Are you familiar with the productions of Minnesota?

Mr. ROWLEY. Yes.

The CHAIRMAN. How will the land here compare with the land of Minnesota?

Mr. ROWLEY. I think it is equal to it and better for some things. It is much better for grass and alfalfa and things of that character. Grain has not been raised here to any great extent. But I do not see why it is not as good a grain country as Minnesota is.

The CHAIRMAN. Have you cultivated alfalfa to any considerable extent?

Mr. ROWLEY. To a sufficient extent to prove that it is a successful crop here.

The CHAIRMAN. How much hay do you produce to the acre?

Mr. ROWLEY. The hay that is produced is native grass.

The CHAIRMAN. I mean alfalfa—how many crops?

Mr. ROWLEY. Two or three crops a year—from 6 to 9 tons.

The CHAIRMAN. How with regard to the small fruits? Do berries flourish well?

Mr. ROWLEY. Yes.

The CHAIRMAN. You have not tried the larger fruits?

Mr. ROWLEY. This country has not been settled very long, but there

are some few places in the valley where they have made a start and say that they can raise them.

The CHAIRMAN. How much farther west does the valley extend?

Mr. ROWLEY. This immediate valley extends up here 30 miles.

The CHAIRMAN. And there are other valleys on the Yellowstone beyond that?

Mr. ROWLEY. Yes.

The CHAIRMAN. For how long a distance?

Mr. ROWLEY. It opens out into valleys all the way along.

The CHAIRMAN. How far up?

Mr. ROWLEY. To the National Park.

The CHAIRMAN. What distance would that be from here?

Mr. ROWLEY. One hundred and fifty miles.

Senator REAGAN. From Billings?

Mr. ROWLEY. Yes.

The CHAIRMAN. Have you ever made any estimate of the entire extent of the valley land of the Yellowstone River from the Park down to the Missouri?

Mr. ROWLEY. No; I never have.

The CHAIRMAN. What county are we in?

Mr. ROWLEY. Yellowstone County.

The CHAIRMAN. It joins on to the county in which Miles City is situated?

Mr. ROWLEY. Yes; Miles City is in Custer County.

The CHAIRMAN. And this joins on to Custer County?

Mr. ROWLEY. Yes.

The CHAIRMAN. How much valley is on this river?

Mr. ROWLEY. I can not say; I never had any occasion to estimate it. But take the two sides of the river, and what is now the Crow Reservation, and there is a large amount of valley land.

The CHAIRMAN. What would be the average width of it?

Mr. ROWLEY. Probably 2 miles wide. This valley broadens out to 8 miles in some places. Two or three miles, probably, would be the average.

The CHAIRMAN. What is the character of the land back from the river?

Mr. ROWLEY. To the north there is a large extent of table land—what is known as the lake basin country—a strip of country running from 20 to 30 miles in width, and perhaps 70 miles in length. It would be a fine agricultural country if it were watered.

The CHAIRMAN. Is there any opportunity to water it?

Mr. ROWLEY. Some think that there is.

The CHAIRMAN. What means of watering it have been suggested?

Mr. ROWLEY. Only by storage reservoirs.

The CHAIRMAN. What opportunities have you for storage reservoirs?

Mr. ROWLEY. That is a matter that has not been investigated. In the country, at the upper end of this basin, which runs up to the mountains, there is a large amount of water during certain seasons of the year—during June and July.

The CHAIRMAN. Is there a stream running through it?

Mr. ROWLEY. No; but probably there is plenty of water up there which could be gotten.

Senator REAGAN. Is it too high at any point for the water from the river to be carried on to it?

Mr. ROWLEY. I think it might be. There is between all the streams rolling country and bench lands.

The CHAIRMAN. What is your first large stream that comes in as a tributary?

Mr. ROWLEY. Below here the Big Horn is the first river.

The CHAIRMAN. That is as large as the Yellowstone?

Mr. ROWLEY. Yes.

The CHAIRMAN. That has streams running into it?

Mr. ROWLEY. Yes.

The CHAIRMAN. Is it toward the south that these streams go?

Mr. ROWLEY. Yes.

The CHAIRMAN. Is it table land there, or how is it?

Mr. ROWLEY. Rolling country. Most of the streams head in the mountains, and then they run down into a rolling country, where nearly all of it can be irrigated.

The CHAIRMAN. What is the character of the land when irrigated?

Mr. ROWLEY. The land is good—nearly all of it.

Director POWELL. You built one of these canals?

Mr. ROWLEY. Yes.

Director POWELL. Can you give us an idea of the cost of constructing a canal?

Mr. ROWLEY. That was built at a time when everything was very high, and all the lumber was bought at a high price.

Director POWELL. Put it in this shape, if you have thought of it in that direction: What does it cost, the original plant, of getting water on to the land—the cost per acre?

Mr. ROWLEY. It would be hard to get at it in that shape. The character of the country in some places is different from what it is in others, and it would cost more in some places than in others.

Director POWELL. How much would it cost where you have seen it? Approximate it.

Mr. ROWLEY. That ditch, about 35 miles long, cost \$100,000.

Director POWELL. How much land will it irrigate?

Mr. ROWLEY. It probably irrigates at its present capacity about 15,000 or 20,000 acres.

Senator REAGAN. Have lateral ditches been constructed to carry off the water?

Mr. ROWLEY. Yes; that is the way it all has to be done. These farms lie quite a distance from the main ditch. Some three or four farmers get together and take out a ditch, and then they will branch out.

Senator REAGAN. How much wheat to an acre will they make on this irrigated land?

Mr. ROWLEY. From 20 to 25 bushels, and perhaps more than that. Wheat has not been raised to such an extent as oats. There has been no market for wheat. There is no mill in this country, and it does not pay to ship wheat east, and therefore it has not been experimented with.

The CHAIRMAN. How many bushels of oats to the acre do they raise?

Mr. ROWLEY. Forty to 60 bushels of oats.

The CHAIRMAN. Is corn raised in this part to any extent?

Mr. ROWLEY. No. But I do not know any reason why they can not raise good corn here.

Senator REAGAN. Will corn have a good time to mature?

Mr. ROWLEY. This country seems to be as good as Minnesota for raising corn.

Senator REAGAN. Have you estimated how much corn to the acre there is raised on irrigated land?

Mr. ROWLEY. No, I have not.

STATEMENT OF H. H. MUND, OF BILLINGS.

The CHAIRMAN. How long have you resided in Billings?

Mr. MUND. Since 1882.

The CHAIRMAN. Have you traveled over the country pretty generally?

Mr. MUND. I have been down this valley frequently, but never back to any place south.

The CHAIRMAN. Have you observed the effect of irrigation here?

Mr. MUND. Yes, frequently.

The CHAIRMAN. How is the land when there is no irrigation?

Mr. MUND. There is nothing raised. That is about it. It is just as you see the country coming up here—all barren.

The CHAIRMAN. You can not produce ordinary crops without irrigation?

Mr. MUND. In a damp season we can raise a small hay crop, but nothing else.

The CHAIRMAN. With irrigation, how is it?

Mr. MUND. Everything increases in productiveness. As Mr. Rowley has stated, from six to nine tons of alfalfa; two tons to the acre of native grass. I have seen the third season two tons to the acre cut on land that was absolutely barren without irrigation.

The CHAIRMAN. How is it with all-around crops?

Mr. MUND. Everything seems to do very well here so far as I can see.

The CHAIRMAN. Have you been farming?

Mr. MUND. No; I do not know millet from barley. I think Mr. Rowley stated those yields too low. I understood that when they raised oats it was forty bushels to the acre. Under irrigation, vegetables are simply wonderful. The potatoes we do not think can be beaten anywhere. I think that holds good in all irrigated countries. I have seen it in Colorado and the Black Hills.

The CHAIRMAN. How does this land compare in productiveness with the land in Colorado?

Mr. MUND. I should think that it is fully as good. It is a different character of soil, so far as I have been able to judge—more gravel there. But no fault can be found with the soil here when it is under irrigation. I have some grass which I would like you to examine. That was brought in from some little distance north of here. That was raised under irrigation. It is about four feet long and it is timothy hay.

[The sample of hay which was introduced by Mr. Mund, by actual measurement was found to be fifty-seven inches in length.]

STATEMENT OF ALEXANDER FRAZIER, OF BILLINGS.

The CHAIRMAN. How long have you resided here?

Mr. FRAZIER. Since 1881.

The CHAIRMAN. What is your business?

Mr. FRAZIER. I am in the grain and fuel business at the present time.

The CHAIRMAN. Have you ever been a farmer?

Mr. FRAZIER. Not much of a farmer.

The CHAIRMAN. Are you familiar with the growing of crops in this country?

Mr. FRAZIER. Yes; I have observed the growth of crops in this country since coming here.

The CHAIRMAN. Have you noticed it anywhere else?

Mr. FRAZIER. Yes, in Nova Scotia.

The CHAIRMAN. Can you raise crops here without irrigation?

Mr. FRAZIER. We can not raise crops here without irrigation. Some seasons, such as last, we have had considerable rain, and some crops could have been raised then without irrigation. But, as a rule, they can not be raised.

The CHAIRMAN. What have you to say of the growth of the crops here with irrigation?

Mr. FRAZIER. It will exceed anything, by natural growth, anywhere else.

The CHAIRMAN. You mean crops produced by rain-fall?

Mr. FRAZIER. Yes. I think our farms can produce one-fourth more than they can anywhere else by rain-fall.

The CHAIRMAN. By irrigation do you get a good crop each year?

Mr. FRAZIER. All the time. There has never been a failure here so far.

The CHAIRMAN. How was it in Nova Scotia? Could you get a good crop every year?

Mr. FRAZIER. If we had plenty of rain. If it were dry we could not.

The CHAIRMAN. Take an irrigated farm here of a given number of acres and one in Nova Scotia of the same number and allow for a period of ten years, what would be the difference between the two farms?

Mr. FRAZIER. The irrigated farm would exceed the other one-quarter, take it year in and year out.

The CHAIRMAN. Not more than that?

Mr. FRAZIER. I do not like to say more; but it might.

The CHAIRMAN. How many tons of alfalfa hay can you produce to the acre here?

Mr. FRAZIER. You can produce three crops during the season, averaging, perhaps, 2 or 3 tons to the crop.

The CHAIRMAN. How much can you produce in Nova Scotia?

Mr. FRAZIER. One crop.

The CHAIRMAN. How much would that be?

Mr. FRAZIER. A ton and a half would be a big crop.

The CHAIRMAN. Have you traveled out over the country outside of this valley?

Mr. FRAZIER. Yes.

The CHAIRMAN. What is the character of the country on the north?

Mr. FRAZIER. Arid, north and south; very dry.

The CHAIRMAN. Is there any chance to irrigate it?

Mr. FRAZIER. There might be from the Yellowstone if it were drawn out high enough.

The CHAIRMAN. Is there any chance for storing water?

Mr. FRAZIER. There is on the lake basin region. North of us, perhaps 30 miles, there are several lakes that might be suitable for storage purposes.

Senator REAGAN. How long has this valley been under irrigation, do you know?

Mr. FRAZIER. Since 1882 or 1883. This large ditch, of which you have heard, was constructed in 1883.

Senator REAGAN. Has the ground been under irrigation that long?

Mr. FRAZIER. Part of it has and part not. There are several sec-

tions of this land unsold and unoccupied, and consequently unirrigated. But farmers have bought the land here, and for miles they are irrigating. Two smaller ditches belong to the farmers themselves.

Senator REAGAN. Does the productiveness of the land increase after the first year's irrigation?

Mr. FRAZIER. I do not know that it increases; it keeps up. There has been no decrease in its capacity so far.

STATEMENT OF L. WHITNEY, OF BILLINGS.

The CHAIRMAN. How long have you resided in Billings?

Mr. WHITNEY. Since 1882.

The CHAIRMAN. What is your occupation?

Mr. WHITNEY. Just now I am county treasurer.

The CHAIRMAN. Are you familiar with the country about Billings?

Mr. WHITNEY. Yes.

The CHAIRMAN. Have you traveled over it considerably?

Mr. WHITNEY. Yes.

The CHAIRMAN. Have you ever been a farmer?

Mr. WHITNEY. Yes; raised on a farm.

The CHAIRMAN. Where?

Mr. WHITNEY. In Illinois. I have also farmed a little in Kansas.

The CHAIRMAN. Have you farmed any here?

Mr. WHITNEY. No.

The CHAIRMAN. Have you observed farming here?

Mr. WHITNEY. Yes.

The CHAIRMAN. What can you say of the farming here by means of irrigation?

Mr. WHITNEY. It is very good.

The CHAIRMAN. In what part of Kansas were you?

Mr. WHITNEY. Lane County, about 300 miles west of Kansas City.

The CHAIRMAN. How does the land here, where you have irrigation, compare with the land in Lane County, Kansas.

Mr. WHITNEY. I think it exceeds the land in Kansas—better land, better soil.

The CHAIRMAN. How is it as to the certainty of crops?

Mr. WHITNEY. With irrigation it is very much better. There they have some very dry seasons, when there is an entire failure of crops. With irrigation here it is certain every year.

The CHAIRMAN. A full crop every year?

Mr. WHITNEY. Yes.

The CHAIRMAN. How does the crop, when produced here, compare with the crop in Illinois—taking the crops all around?

Mr. WHITNEY. The small grains are produced here at the present time better than in Illinois. When Illinois was new it produced very good crops of wheat and oats; but now they do not get such crops there.

The CHAIRMAN. How is it here with potatoes?

Mr. WHITNEY. We have very good potatoes here.

The CHAIRMAN. How is it with vegetables of all kinds?

Mr. WHITNEY. Vegetables grow better here than in Illinois.

The CHAIRMAN. Of course, you have not tried any but the small fruits?

Mr. WHITNEY. Small fruits grow very well here. I was out on a

little fruit farm this evening and it was appearing very well. We were in hopes of taking you out there to look at it.

The CHAIRMAN. Does alfalfa grow well here?

Mr. WHITNEY. Yes.

The CHAIRMAN. Have you examined to see how much alfalfa they produce here when it is properly cultivated?

Mr. WHITNEY. The man who has the largest field of alfalfa here told me that he gets 2 tons to the acre, and that he cuts three crops. He was telling me that he expects to get four crops this year. I was out at his place, and the alfalfa was 2 feet in height and as thick on the ground as it could stand.

The CHAIRMAN. What use do you make of alfalfa?

Mr. WHITNEY. It is an excellent food for all kinds of stock.

The CHAIRMAN. How does it compare with native grass?

Mr. WHITNEY. In regard to its quality as a food, do you mean?

The CHAIRMAN. Yes.

Mr. WHITNEY. Our native grass is a very fine grass. It makes a fine hay. It is very rich. We have not tried the alfalfa long enough to see which would be the better grass.

The CHAIRMAN. Have you used alfalfa in feeding hogs?

Mr. WHITNEY. Yes; it has been fed to hogs. They seem to do very well on it.

The CHAIRMAN. Have you ever estimated the extent of country along the river in this county that could be irrigated?

Mr. WHITNEY. We claim that there are nearly 100,000 acres in this valley, and we are situated at the lower end of it.

Senator REAGAN. Do you mean in this county?

Mr. WHITNEY. Yes; it is all in this county. There are nearly 100,000 acres. Something like 60,000 under the big ditch.

The CHAIRMAN. There are other valleys in this county?

Mr. WHITNEY. Yes; there are 40,000 acres in this valley above that ditch.

The CHAIRMAN. How much below?

Mr. WHITNEY. About 60,000 under the ditch, and 40,000 above. This valley ends right here across the bridge.

The CHAIRMAN. On the river valley in this county, how is it?

Mr. WHITNEY. Below, there is a table-land—I hardly know the extent of it—which lies next the river, and which, if it could be irrigated, would amount to 100,000 acres more.

The CHAIRMAN. That is this side of the Crow Reservation?

Mr. WHITNEY. Yes; below us here. We are in the center of the county. That extends some 60 miles below us.

The CHAIRMAN. How is it as to the Crow Reservation? That is in your county, is it not?

Mr. WHITNEY. For judicial purposes. It does not belong to this county.

The CHAIRMAN. How is it there?

Mr. WHITNEY. That is a pretty large tract of country—two, or two and one-half million acres of land; I do not know the exact amount.

The CHAIRMAN. Can it all be irrigated?

Mr. WHITNEY. It can be all irrigated. The lands south are different from the lands north. The land south is cut up by streams, and each of those streams has a valley, and the bench-land could be irrigated because it has a good down grade.

The CHAIRMAN. All that land across the river, then, can be irrigated?

Mr. WHITNEY. Yes, in the reservation. For instance, there is a lit-

the stream over which they have built a railroad to go to the coal mines. I was with the surveyor, and he told me that the fall in the stream there was 210 feet by actual survey.

The CHAIRMAN. Then there is a large quantity of land in this county that can be irrigated?

Mr. WHITNEY. Yes. Besides that there is a tract which has been mentioned as the lake basin country. That is between this and the Mussel Shell River. The soil in that country is different from the soil here—it is the best soil in this country; but there are no streams whatever running through it.

The CHAIRMAN. How do you propose to irrigate that?

Mr. WHITNEY. If we were going to experiment I should try the storage system. I should go up those mountains and try and get those little streams into a reservoir. It has never been examined very thoroughly, but parties who have traveled over the country say that they think an irrigating ditch can be built. By a little stream of water called the Sweet Grass, 20 miles in length, the water could be brought to the basin. I think it possible for that to be done. Then irrigation by means of artesian wells has been suggested.

The CHAIRMAN. Have any artesian wells been sunk in this vicinity?

Mr. WHITNEY. Only here in town, but that well was not very deep.

The CHAIRMAN. How deep is it?

Mr. WHITNEY. A little over a thousand feet.

The CHAIRMAN. Through what formations did the drill pass?

Mr. WHITNEY. Slate, all the way.

The CHAIRMAN. Did you not go through the slate?

Mr. WHITNEY. They did not go through it. It is like the formations of those bluffs across the river.

The CHAIRMAN. Was the slate flat or did it tilt?

Mr. WHITNEY. Flat. It is a sort of shale instead of slate. I was wrong in saying it was slate; it was shale.

The CHAIRMAN. You did not find any other strata?

Mr. WHITNEY. No, nothing but that. The man who had charge of the work told me that just as they quit they were getting into a lighter substance, whatever it was, and apparently more sandy. But the money gave out and they stopped right there, and it has never been taken up since. It does seem to me that a well system ought to be tested, especially in this lake basin country.

The CHAIRMAN. You have no necessity for it here?

Mr. WHITNEY. Not in the valley. The town is supplied with water, and we can get water easily enough in the valley. But here are bluffs 250 feet high which would have to be irrigated, and those bluffs are of the same height anywhere along the stream. I have estimated carefully about 450,000 acres of land, and probably every acre of it could be brought under irrigation.

The CHAIRMAN. Is it rich land?

Mr. WHITNEY. Richer than that in the valley. It is the wash from the hills. Go up there and look at the sage brush and the stuff that grows there and you will see it is rich.

The CHAIRMAN. Is there a large growth of sage brush up there?

Mr. WHITNEY. Yes.

The CHAIRMAN. Do you in this country regard that as an indication of good land?

Mr. WHITNEY. Yes. I have no doubt from what they tell me they have raised there that that land would yield 40 bushels of wheat to the acre.

Senator REAGAN. How long has this country about Billings been settled?

Mr. WHITNEY. There were a few settlers here before the town was started, but they were scattered along the river. The most of the settlement has been made within the last seven years.

Senator REAGAN. Has some effort been made here to raise apples, pears, plums, and cherries?

Mr. WHITNEY. Plums and cherries, I think, would grow, and some have been raised here. As to apples and pears, I do not think anything has been done in that line. There have been a few trees put out.

Senator REAGAN. Do they seem to grow well?

Mr. WHITNEY. The trouble with fruit trees seems to be the dryness. Unless they are well irrigated they are apt to be killed in the winter. They will have to be very carefully managed and the ground irrigated to make a success of them. But small fruits—plums and cherries—would grow well. We have wild plums growing on the reservation.

The CHAIRMAN. Has anybody undertaken in this country to write a description of it; its resources? Have you any documents on that subject?

Mr. WHITNEY. Mr. Smalley has written something of that kind.

STATEMENT OF J. H. CONRAD, OF BILLINGS.

The CHAIRMAN. What is your occupation?

Mr. CONRAD. I am a ranchman.

The CHAIRMAN. You raise stock?

Mr. CONRAD. Yes.

The CHAIRMAN. In what part of the county?

Mr. CONRAD. I am raising stock, not especially in this county but in this Territory, and also in Wyoming.

The CHAIRMAN. Then you have traveled all over the country about here?

Mr. CONRAD. Yes. I have spent about twenty years traveling over these prairies.

The CHAIRMAN. Are you familiar with the valley of the Yellowstone generally?

Mr. CONRAD. Yes. From the head to the mouth.

The CHAIRMAN. And with the country on either side?

Mr. CONRAD. Yes.

The CHAIRMAN. Have you ever made an estimate of the amount of valley land there is in the Yellowstone?

Mr. CONRAD. There are 400 miles of valley land in length.

The CHAIRMAN. What would be the average width?

Mr. CONRAD. It is safe to say 5 or 6 miles.

The CHAIRMAN. Do you think it would average 5 miles?

Mr. CONRAD. Yes.

The CHAIRMAN. Taking out the space of the river, do you think the real valley land would average 5 miles?

Mr. CONRAD. Yes. There are a number of bottoms, like this we have here, of from 50,000 to 100,000 acres, of what would be called bottom land. That can be irrigated at a very small cost. But my experience of this country is that fully 85 per cent. of it could be irrigated by the Yellowstone, Missouri, Big Horn, and their tributaries.

The CHAIRMAN. You would have to resort to storage then?

Mr. CONRAD. Not necessarily. The Yellowstone River has sufficient

fall to irrigate all the prairie lands from the mountains to the Missouri River, where it empties.

The CHAIRMAN. You have some bad lands that you would exclude from the prairie land?

Mr. CONRAD. Yes. I think it is a safe estimate to say that 85 per cent. of the land is susceptible of cultivation, and that would be productive in raising crops.

The CHAIRMAN. That is, if all the water were made available?

Mr. CONRAD. Yes.

The CHAIRMAN. How wide a space would you make? You say it is 400 miles from the head of the valley to the mouth of the river?

Mr. CONRAD. Yes; from the mouth of the river to where it comes out of the mountains it would be that length.

The CHAIRMAN. Then how much north and south?

Mr. CONRAD. I think it could be irrigated for 50 miles on each side of the river. When you get back on the table-lands the soil is very much richer as a rule than on the bottoms. Take it in the basin of the country and on the Crow Reservation, and on both sides of the river, it seems to me to be a rich black loam soil; the greater portion of it, except where you get into these bad lands.

The CHAIRMAN. What has been the result of irrigation where it has been practiced?

Mr. CONRAD. I have watched it while I have been in the Territory, for twenty years, and I have never known a failure of crops where they had water to irrigate the crops. As compared with my observation of crops in the East, they are very much greater. It is safe to say 50 per cent. better here. East of here, about 125 or 150 miles—in Wyoming—the mountain streams run out of the mountains, where it is very easy to irrigate, and the farmers there raise from 40 to 50 bushels of wheat to the acre.

The CHAIRMAN. As a regular thing?

Mr. CONRAD. As a regular thing; year in and year out. They also raise from 40 to 60 bushels of oats; and as to potatoes I would not undertake to say exactly, but I am safe in saying that it is double the yield of anything I have seen in the United States elsewhere.

The CHAIRMAN. And you have no failure of crops?

Mr. CONRAD. None whatever, of any kinds of crops.

The CHAIRMAN. How is it with your experience in the East? Would you not have rain some time in the spring and then drought and then rain in the harvest, and so on?

Mr. CONRAD. I began farming in Virginia, and we got three crops out of five; that is to say, three years in five, on an average, we had a good crop.

The CHAIRMAN. If you were to take the best land in Virginia and land irrigated here and compare the production for, say, ten years, what would be the difference between the two places?

Mr. CONRAD. It would be more than double. In the first place, you raise 50 per cent., year after year, more than you can possibly raise without irrigation.

The CHAIRMAN. More than their best crops in the most favorable seasons; and you would get a sure crop every year?

Mr. CONRAD. You would get ten crops in ten years; whereas you are in big luck if you get five full crops in ten years in the States.

The CHAIRMAN. Have you observed the production of alfalfa?

Mr. CONRAD. Yes. They get three crops a year of it. And here it is proven that they get in this valley from 6 to 10 tons an acre. I

know of land in Montana that when watered for four or five years has produced more than that, but how much I would not like to say.

The CHAIRMAN. Does it improve after a little while?

Mr. CONRAD. It improves year after year.

The CHAIRMAN. You do not know how long it would continue to do so?

Mr. CONRAD. They have been raising alfalfa about here for seven or eight years, and they seem to get an improvement in it each year. The roots of the alfalfa seem different from those of other crops. They run down to a very great depth. In Nevada they are better posted on alfalfa than they are here.

The CHAIRMAN. It has been a great success in Nevada?

Mr. CONRAD. Yes. I have not seen a failure where they have watered for twenty years in this country.

The CHAIRMAN. If all the lands susceptible of irrigation were brought under cultivation there would be a good deal of land remaining for pasturage, would there not?

Mr. CONRAD. Yes; the remaining land would be very useful for pasturage. In fact there is none of the land that is not susceptible of irrigation except these bad lands that you came through this morning before you came to Glendive. We have not a great deal of bad land in Montana. The bad lands do not extend very far back into the Territory.

The CHAIRMAN. The worst view of it is had in coming up the railroad?

Mr. CONRAD. Yes. You look out of your car window and see the bluffs on each side, and you think perhaps the prairie country is the same way. But when you get up to the benches you find it to be the finest land in the country; better land than the State of Illinois. The great majority of it is table-land, and for hundreds of miles it is as level almost as a floor. And all of that can be watered by bringing canals from those rivers. I do not think storage would be necessary at all.

The CHAIRMAN. If there is not water enough in the rivers, you can increase the water by storage, can you not?

Mr. CONRAD. Yes; by simply building the dam in the natural place.

The CHAIRMAN. Is it your experience in travelling over the mountains that almost all streams and all feeders head in flats or lakes, as a rule?

Mr. CONRAD. No. There are no streams that I know of in Montana that do not head in these mountains here, or near some mountains.

The CHAIRMAN. Is there a convenient place, as a rule, for making reservoirs?

Mr. CONRAD. Yes. You can find those wherever you want them.

The CHAIRMAN. Are there plenty of such places in this Territory?

Mr. CONRAD. Yes. The land runs into these coulees.

The CHAIRMAN. What do you mean by coulees?

Mr. CONRAD. Little places that dams can be made in and would hold an unlimited amount of water.

The CHAIRMAN. Are they found numerously throughout the country here?

Mr. CONRAD. Yes.

The CHAIRMAN. Along the little streams?

Mr. CONRAD. Yes.

The CHAIRMAN. Would it be of any advantage to the people here to have a survey of this land to show how much land could be irrigated, and how much water could be stored, and estimates of the cost of construction, etc.?

Mr. CONRAD. I should think it would be of decided advantage.

The CHAIRMAN. The Government has undertaken to make these investigations and surveys, and is going to give considerable attention to the subject. You are aware that the law already reserves all places on the public lands that are adapted for the purposes of making reservoirs or ditches, and all rights of way of that character?

Mr. CONRAD. Yes; we have embodied that in our constitution here now. We have set aside all rights of that kind that may be wanted in the future, without cost.

The CHAIRMAN. Have you any other facts that you would like to state to the committee?

Mr. CONRAD. I simply wish to say that when you get through with this work I hope you will not forget the Yellowstone Valley. Here is where we have the most farming land of any place in Montana.

Senator REAGAN. Is it your opinion that the continued irrigation and cultivation of this valley has increased its production?

Mr. CONRAD. Yes, decidedly. Where the farms are continuously cultivated the farmers seem to get better crops each year.

Senator REAGAN. Have you ever reflected that that might be the result of the fertilizing matter in the water?

Mr. CONRAD. Well, I do not know but that is it. It is probably because it washes out the alkali and makes the land susceptible of cultivation.

The CHAIRMAN. Pond water is a great fertilizer.

Mr. E. V. SMALLEY. I should like the committee to ask Mr. Conrad something about this great Judith Basin above here.

Mr. CONRAD. That is one of the most fertile valleys in this country.

The CHAIRMAN. Is it being cultivated?

Mr. CONRAD. Yes.

The CHAIRMAN. Where is it?

Mr. CONRAD. Between here and Fort Benton, on the Missouri River. It runs into the Missouri River. The farmers are irrigating it in a small way, but they have not sufficient water to irrigate the whole of it. As to raising fruit, particularly plums, it used to be known years ago that plums of unusual size were produced there.

Senator REAGAN. Have they tried to raise apples and pears successfully?

Mr. CONRAD. They have done so in the western part of the Territory, but here they have not tried it yet. The farmers have had all that they could do to raise potatoes and things that were indispensable. They raise a good deal of grain there, because it is easily irrigated, and the farmers have been able to irrigate it with their plows at small cost. But that basin is not more productive than these bench lands up here would be if you got water on them.

Senator REAGAN. What are the results of farming in that basin?

Mr. CONRAD. They have made a good deal of success of it, because each farmer has been able to go out and build his little ditch and get water on it. Here is a farming country over here that they raised a good deal of oats on, and the supply is greater than the demand because there is no railroad in there yet. But the streams run out of the mountains and the farmers can irrigate their land easily, and so they can raise everything easily. The best evidence of this irrigation you will see to-morrow along the Gallatin when you get to Bozeman. It is no more productive than this valley, but it is easily irrigated, and the farmers have irrigated that whole valley.

Senator REAGAN. How much land is under cultivation by irrigation in that valley?

Mr. CONRAD. I would not undertake to say, but, I should judge, about 100,000 acres. They have two large flour-mills there. They raise fruits and vegetables in unlimited quantities.

Senator REAGAN. Do they raise such fruits as apples and peaches?

Mr. CONRAD. I will not say as to peaches, but I know they raise apples. I would not like to say about pears. Good strawberries, however, and fruits of that kind are raised there, and are shipped all over the Territory. They have not raised many apples. With a frontier farm it is all the farmer can do the first five or six years to get the water on to his farm and to raise the substantial things of life with which to support his family. After that is done he goes to work and raises some of the luxuries. I have seen as fine corn raised here near Billings as I have ever seen in Virginia.

Senator REAGAN. How are the land laws suited to the occupancy of this country with regard to land that can be irrigated?

Mr. CONRAD. The land laws are good with the exception of the delay that has occurred in Washington in getting titles to land.

Senator REAGAN. Where there is considerable capacity for irrigation can homesteaders take the land and make it successful?

Mr. CONRAD. Yes. But they can not do so where there is a large expense connected with irrigation, because they can not get the water out. To take the land under the desert land act costs more to get the water out than the land is worth after you get the water on it.

Senator REAGAN. How so?

Mr. CONRAD. Well, one man can only take up 640 acres under that act, and to dig a ditch ten miles long would cost a good deal of money.

Senator REAGAN. What kind of land laws would you suggest that would be better?

Mr. CONRAD. I could not answer that question intelligently. I do not know what suggestion to make. I should think, though, that if this system of irrigation was carried out by the Government all this land that lies out here now an idle waste, would be taken up by actual settlers and farmers.

Senator REAGAN. It would be necessary to have the laws so modified that they could combine together, would it not, and operate it as a company?

Mr. CONRAD. No. If they could get water there they could take it up under the homestead and pre-emption act, as they do now.

Senator REAGAN. They could do that out on the prairies where they could get at it by individual effort?

Mr. CONRAD. Yes.

Senator REAGAN. But where they could not do it by individual effort then there must be some arrangement whereby they can combine, must there not?

Mr. CONRAD. Yes. In that event, in case the Government does not go to work and irrigate the land the only way I should think that the land could be irrigated would be to sell it in large lots to companies that would go to work and irrigate it.

Senator REAGAN. Would not that create a monopoly in land?

Mr. CONRAD. Of course it would. Instead of the farmer getting the land for \$2.25 or \$2.50 an acre, he would have to pay \$10 or \$15 or \$25 or whatever they would sell it for. The only true system for putting it in the hands of the actual settlers would be for the Government to dig these canals and sell the land at a price, if necessary, that would pay

the expense of digging and maintaining the canals, or let them have a rental for the water. We pay \$2 an inch for the water in this valley now.

Senator REAGAN. Do you think it is desirable to have the title of the land and water separate, or ought they to be together?

Mr. CONRAD. They ought to be together. The land would be worth nothing without the water.

Senator REAGAN. That would be a pretty bad monopoly, then, if they could monopolize the water.

Mr. CONRAD. Yes. But you could irrigate these bench lands and give the land and water to the actual settler at say double what the Government charges for it now; and it would be settled very quickly, and it would be very much cheaper to the farmer than trying to irrigate it himself.

Senator REAGAN. Do you think that if the State had these lands they could irrigate and sell them and not let them fall into the hands of monopolies that would take advantage of the situation?

Mr. CONRAD. Well, the State of Texas did not do it.

Senator REAGAN. There is some danger in letting the State do it, you think?

Mr. CONRAD. Well, I would not say that. But I think that the National Government has managed the land so far and has managed to keep it out of the hands of monopolies, and I do not see why they could not continue to do so.

The CHAIRMAN. Is there any other gentleman here that can give us any other information?

Mr. CONRAD. Captain Merritt can tell you a good deal.

Captain MERRITT. I am not sufficiently familiar with the topography of the country to give the committee any information that would be of value. I have been here only since December, and my time has been taken up in constructing a little railroad up here to Red Lodge. I know but very little of the country around here from actual observation.

FURTHER STATEMENT OF H. H. MUND, OF BILLINGS.

The CHAIRMAN. Is there something you wish to add to what you have already stated?

Mr. MUND. I wish to call the attention of the committee to two or three things that have been omitted from the testimony given here.

The question was asked whether alfalfa was ever used for fattening hogs. It is not, I think, used for that, but it has been used for fattening sheep. Last fall a man had 500 yearling wethers, as they were called, and paid for them \$1.75 apiece. At shearing-time they sheared 14 pounds 2 ounces to the fleece. He sold the balance on the basis of \$3.50 apiece. That is, he got a ewe and a lamb in exchange for that alfalfa. That is on Mr. Steward's ranch, a little way out of here.

As to artesian wells, it was attempted to get water from artesian wells here at an early day, and I am very strongly of opinion that water was reached and passed. I am satisfied that water was reached long before the 1,000-foot depth was reached, though we did not get a flowing well.

With reference to the question of irrigation, it must be remembered that while there is better irrigation at Bozeman than here, yet they have been irrigating there for twenty-five years, while at this point irrigation has been tried only for five or six years.

With regard to the desert land law, the Government has allowed a man who has an actual interest in one of those ditches to prove up. That is, if he had one-fourth or one-tenth interest in a regularly-constructed irrigating ditch that brought water to the land, it was considered that he had done the work of reclaiming the land.

STATEMENT OF F. COUSINS, OF BILLINGS.

The CHAIRMAN. How long have you resided in Billings?

Mr. COUSINS. Since 1883.

The CHAIRMAN. Are you familiar with this region.

Mr. COUSINS. I am.

The CHAIRMAN. What have you to say with regard to irrigation?

Mr. COUSINS. I would like to call the attention of the committee to a fine tract of land north of this basin country and north of the Musselshell. It is a tract of country that can be irrigated with stored water. There is not enough water in the streams that flow from the mountains, but there are excellent facilities for storing the water by means of dams at the heads of those streams where they issue from the mountains. The tract is about 30 miles long by an average of 10 miles wide.

The CHAIRMAN. What is the character of the land?

Mr. COUSINS. It is of the same general character that prevails through this country, except that there is more black loam near the mountains. At a distance of a few miles from the mountains it assumes this gumbo sage-brush character.

The CHAIRMAN. Has there been much farming done in the valley?

Mr. COUSINS. There has been some done near the streams. There are really no valleys; they are mostly benches.

The CHAIRMAN. They have done some irrigation there.

Mr. COUSINS. Yes; a good deal of irrigation. That specimen of timothy grass that you have had before you came from that country. There are several fine streams, but there are a great many small streams from which water can be stored and carried out to the plains with good effect.

The CHAIRMAN. Is there a considerable field of that kind of grass?

Mr. COUSINS. Yes; there are extensive fields of that kind of grass.

The CHAIRMAN. Have they raised any alfalfa in that region?

Mr. COUSINS. Very little. They have perhaps done so for a year or so, but not much yet. They have raised the natural hay, however.

The CHAIRMAN. Are they raising a variety of crops there?

Mr. COUSINS. Oats and hay make the principal crops. They don't raise any vegetables but what they want for their own use.

The following papers were filed with the committee at Billings:

THE LANDS OF YELLOWSTONE COUNTY.

Within the limits of Yellowstone County, Mont., there are about twenty townships, or 450,000 acres of land, which are marked upon the Congressional surveys as "Agricultural lands."

This tract lies along the divide between the Musselshell and Yellowstone Rivers, and although it is drained on each side by *coulées* running to the above rivers, there are no living streams throughout its whole extent, and but few springs, except in the rainy season. The surface is very generally level, or so nearly so that it could very readily be irrigated, provided a source could be found from which to obtain the water. The soil is very rich, being washed from the hills and uplands; undoubtedly it is the richest soil in this region. In several places there are small ponds, evidently

formed by the surface-water collecting in them, which become nearly or quite dry in very dry seasons, though they are usually great resorts for ducks and geese in the fall. Wells have been dug at several points along the stage-line which crosses this section from Billings to Lavina, and water is usually found at 15 to 20 feet.

This section should be thoroughly investigated, with a view to the practicability of its irrigation, either by going to the mountains west and collecting the water from the small streams rising there—bring it by an irrigating ditch to the proper points for distribution over this area—or artesian wells should be dug upon various portions of the tract, in order to thoroughly settle the point as to whether they would be successful or practicable. This scheme would be impracticable for private enterprise from the difficulty of insuring a reasonable return for capital invested, but if undertaken by the Government and if successful, a return would be made at once by the sale of the land, which at present is unsalable and only fit for grazing.

LIST OF IRRIGATION WORKS IN THE YELLOWSTONE VALLEY.

1. *M. and M. Land Irrigation Company's Ditch*.—Bailey & Billings, agents, Billings, Mont. Built in 1882 and 1883; 35 miles in length; 24 feet wide at bottom; will carry 3 feet of water; capacity about 7,000 inches. It will irrigate 15,000 acres or more. Covers about 60,000 acres. Water is sold at \$2 per inch per annum. Built at an expense of about \$90,000.

2. *Crayon Creek Ditch*.—Address, Billings, Mont. Built in 1885, by S. H. Erwin, J. S. Danford, J. Dennison, *et al.* It is 15 miles in length; capacity about 2,000 inches; built by labor of the stockholders. The company has 1,000 shares, valued at \$10 each; stock paid by labor on the ditch, and each stockholder has a right to a miner's inch at least of water; but they actually receive nearly 2 inches on each share of stock owned.

3. *Italian Company's Ditch*.—Address, Park City, Mont. It is about 10 miles in length. Supplies about 10 ranches of 160 acres each; was built in 1887.

Mill Company's Ditch.—Address, Perry Whitsett, Park City, Mont. It is about same size and capacity as the Italian Ditch; has 10 share-holders, and cost about \$300 to each in labor; was built in 1889.

5. *Clark's Fork Company's Ditch* was built in 1882; is about 4 miles in length; owned by and supplies water to six ranchmen, each owning about 160 acres.

All the above ditches supplied by the Yellowstone River.

The McAdow Ditch, built by Mr. P. W. McAdow, is some 2½ miles in length, but can only be used in high water, and is a complete failure this year from that reason.

There is estimated to be at least 40,000 acres in the Clark's Fork Valley of the Yellowstone, in which the foregoing ditches are located, which would be available for cultivation provided water could be used, but it would be at considerable expense on account of the distance the water would have to be conveyed. It could be reached from the Yellowstone, and the supply would be ample. This land lies above all the present ditches.

Crops have been raised in this valley of wheat, from 25 to 40 bushels; of oats, from 50 to 70 bushels; of hay, from 1 to 1½ tons; and of alfalfa, usually 2 tons each cutting per acre and three cuttings each season.

All root crops are very fine and large. Potatoes are mealy, large size, and always sound to the core. The crop is 300 to 400 bushels per acre.

Water should be supplied about eight months in the year, as it is necessary to use it upon some portion of the growing crops or in preparation for planting them, or upon the grass and hay lands, from the time frost is out of the ground until the ground is again frozen in the fall (which is sometimes nearly Christmas). The elevation of Billings above the sea is 3,115 feet. Our soil is excellent—a loam, somewhat sandy. It is usually estimated that an inch of water will irrigate an acre, and if carefully used will probably do a little more, but this, of course, varies with the nature of the soil. Without irrigation this valley would be practically useless for purposes of agriculture.

Adjourned.

ON TRAIN NEAR BILLINGS, August 8, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF JAMES D. WHELPLEY, OF LIVINGSTONE.

The CHAIRMAN. How long have you resided in Montana?

Mr. WHELPLEY. Nine years.

The CHAIRMAN. How long in Livingstone?

Mr. WHELPLEY. About a year.

The CHAIRMAN. What county is this?

Mr. WHELPLEY. Park County.

The CHAIRMAN. Are you familiar with the topography of the country?

Mr. WHELPLEY. I am fairly well familiar with Park County.

The CHAIRMAN. Have you considered the matter of irrigation?

Mr. WHELPLEY. Not so much in Park County as I have in Fergus County.

The CHAIRMAN. Where is that?

Mr. WHELPLEY. North of Billings.

The CHAIRMAN. Have you resided in that county?

Mr. WHELPLEY. Yes, I resided there for four years.

The CHAIRMAN. And you considered the matter of irrigation relative to that county?

Mr. WHELPLEY. Yes, practically.

The CHAIRMAN. Will you give us a description of the land that can be reached by the flow of the streams, and what success has been met with where irrigation has been practiced?

Mr. WHELPLEY. Fergus County is included in what is known as the Judith Basin, which is the subway drainage of the Judith River, which runs into the Missouri. The Judith is fed by a large number of spring creeks that rise in the mountains and form the basis of the river; whereas the river itself has comparatively little water in it. There is a large amount of water distributed over the basin.

The CHAIRMAN. Does much water go down the river in flood times?

Mr. WHELPLEY. A great deal. But the country is peculiar, owing to the sinkage of water. It is like it is in other parts of the Territory—the upper part is coarse gravel, and the real bed of the stream is 40 or 50 feet below the surface of the ground. The flow ceases in the spring, the water sinks into the earth, and for months the streams are dry.

The CHAIRMAN. How would you prevent the water sinking?

Mr. WHELPLEY. The only way I have seen it done is by puddling the river bed. The sawdust and dirt fill up the cracks between the boulders.

The CHAIRMAN. Could it not be done by ditches from the original bed?

Mr. WHELPLEY. You will find that every inch of water in the basin is covered by water rights.

The CHAIRMAN. Is there any opportunity there to store water?

Mr. WHELPLEY. There is at the head of the Judith, but you would interfere with water rights.

Senator REAGAN. What do you mean by "water-rights"?

Mr. WHELPLEY. We have no good law on that subject in this country; we use the California law, and it is defective for this Territory. That is one of the first things to settle in this country.

The CHAIRMAN. Do you allow a person to hold a water-right without using it?

Mr. WHELPLEY. By the common law he can acquire a right by filing his papers within one year, or else he acquires the right by the first use of the water.

Senator REAGAN. Under what law is that done?

Mr. WHELPLEY. They use the California law here.

Senator REAGAN. Did your legislature adopt the California law as the law of this Territory?

Mr. WHELPLEY. No; I do not think it has done so.

Senator REAGAN. It is a custom of the country?

Mr. WHELPLEY. Yes.

The CHAIRMAN. Is your convention which is in session at Helena likely to incorporate in the State constitution the provision which is in the constitution of Colorado?

Mr. WHELPLEY. It has not been adopted, and it is a question whether it will be or not.

The CHAIRMAN. Leave all questions of law out of the subject and give us the physical conditions of that valley. Could water be stored there so as to increase the volume?

Mr. WHELPLEY. Yes; I think it could be.

The CHAIRMAN. In addition to the Judith River, are there any other creeks and streams coming into the valley?

Mr. WHELPLEY. They are all tributaries of the Judith River.

The CHAIRMAN. They come in from both sides?

Mr. WHELPLEY. Yes. It is a pretty well watered plain. There is one stream there which is remarkable—Big Spring Creek.

The CHAIRMAN. I noticed coming along this morning that some of the farmers had allowed the water to stand on their land. Have you taken into consideration the question of drainage as well as that of irrigation?

Mr. WHELPLEY. The question of drainage is not agitated with us very much; the question with us is enough water.

The CHAIRMAN. Do you not know you can have too much water?

Mr. WHELPLEY. Yes; but I think in alkali valleys like this of Billings, where the soil is clay, most of the land drains itself very rapidly.

The CHAIRMAN. They will have to be very careful of that kind of land or lack of drainage will spoil it.

Mr. HINTON. Have you any statistics in regard to this district?

Mr. WHELPLEY. No; there is no map in existence to-day, topographical or any other character. I have myself most of the maps of Montana. There are little patches of land that have been surveyed for ranches, but they are so disjointed as not to permit of a connected map of the whole country. Most of this surveying was done by the War Department, as I understand, and the original map is made from these surveys. They did a good deal of it by guess work. I know the map is wrong, being thoroughly acquainted with the country.

The CHAIRMAN. Are you acquainted with the country further east of the Yellowstone?

Mr. WHELPLEY. The Judith River becomes a very large stream before it reaches the Missouri River. But there is land that will not be used for a great many years—it is bad land.

The CHAIRMAN. Have you been on the table lands that are on both sides of the Yellowstone River?

Mr. WHELPLEY. On the north side, yes.

The CHAIRMAN. What kind of territory is that?

Mr. WHELPLEY. It comprises long stretches of table lands broken by coulées.

The CHAIRMAN. What do you mean by "coulées?"

Mr. WHELPLEY. Ravines. Coulée is the Montana name for ravine; a coulée is a ravine; they gradually lead into larger coulées or ravines between the divides. The divides consist of long stretches of table land as a general rule.

The CHAIRMAN. Is it good land?

Mr. WHELPLEY. Yes.

The CHAIRMAN. Are you an engineer?

Mr. WHELPLEY. Yes; I came out here for that purpose, to practice my profession.

The CHAIRMAN. What are the chances of getting out the waters of the Yellowstone onto these table lands?

Mr. WHELPLEY. I do not think it is practicable.

The CHAIRMAN. Many engineers tell us it is practicable.

Mr. WHELPLEY. It may be on the plateau for a limited number of miles back of Billings. But I should not consider it practicable for a number of years to come.

The CHAIRMAN. I am not talking of the number of years it will take, but whether it can be done?

Mr. WHELPLEY. Yes, it can be done.

The CHAIRMAN. From your observation what is the result of irrigation, so far as producing crops is concerned?

Mr. WHELPLEY. Better crops are produced here than in rainy sections.

The CHAIRMAN. From what country did you come originally?

Mr. WHELPLEY. New York State.

The CHAIRMAN. From the interior.

Mr. WHELPLEY. Part of the time. New York State is my home.

The CHAIRMAN. You have seen land cultivated in the East?

Mr. WHELPLEY. Yes; I have seen the finest in New York State.

The CHAIRMAN. Take the land in New York State for a number of years and compare it with irrigated land in Montana, and what is the result?

Mr. WHELPLEY. I think in small grains the productiveness per acre is larger here. There is no fertilizing done here—it is virgin land.

The CHAIRMAN. And how is it as to regularity of crops?

Mr. WHELPLEY. We have an absolute regularity of crops.

The CHAIRMAN. Is that the case in New York?

Mr. WHELPLEY. No, the crops vary there.

The CHAIRMAN. If you were to compare land in the two places for a period of ten years which would have the advantage—the land in New York or in Montana?

Mr. WHELPLEY. The land here.

The CHAIRMAN. How much advantage, taking all around crops?

Mr. WHELPLEY. There are a great many things that grow in New York that can not be produced here.

The CHAIRMAN. Take such crops as can be produced here.

Mr. WHELPLEY. I think this country would have the advantage.

The CHAIRMAN. Have you given any attention to alfalfa?

Mr. WHELPLEY. I have seen three crops obtained in one season.

The CHAIRMAN. How much of a crop?

Mr. WHELPLEY. Four tons to the acre.

The CHAIRMAN. In the three crops.

Mr. WHELPLEY. No, 12 tons to the acre in the three crops.

The CHAIRMAN. Have you seen 12 tons produced to the acre here?

Mr. WHELPLEY. Yes.

The CHAIRMAN. How would that compare with Livingston, where they raise garden truck?

Mr. WHELPLEY. It will compare favorably.

The CHAIRMAN. Does your land improve or retrograde by irrigating?

Mr. WHELPLEY. The alkali becomes removed from the soil, and the soil becomes better by irrigating.

The CHAIRMAN. It is a fact that running streams and stored water furnish a good deal of fertilization.

Mr. WHELPLEY. I went into the Judith Basin in 1881, and there was practically no farming done there. When I left there in 1885 they were raising winter wheat without irrigation close to the mountains. But it was only where the snow had been excessively deep in winter that it could be raised.

The CHAIRMAN. That would occur only where there was plenty of snow?

Mr. WHELPLEY. Yes; but there were certain localities where it did not fail.

The CHAIRMAN. But, as a rule, you require irrigation?

Mr. WHELPLEY. Yes.

The CHAIRMAN. How are the hill-sides as to furnishing food for stock in summer?

Mr. WHELPLEY. They are very fine.

The CHAIRMAN. They are claimed to be unsurpassed, I believe?

Mr. WHELPLEY. Yes; they are unsurpassed.

The CHAIRMAN. What kind of country would you have here if the land was susceptible of irrigation, if irrigated and cultivated, and the plains used for stock-raising?

Mr. WHELPLEY. We have not a market even if we had it all irrigated and cultivated.

The CHAIRMAN. Could you not raise stock?

Mr. WHELPLEY. There is a certain limit to stock-raising.

The CHAIRMAN. Do you not think there is a market for all the meat you can produce?

Mr. WHELPLEY. If you are going to flood the country with stock you will have to raise very much more hay.

The CHAIRMAN. If you can provide winter feed, there is no limit to the stock you can raise here?

Mr. WHELPLEY. None in the world.

The CHAIRMAN. Then if you had it irrigated and cultivated to such extent as to furnish food for cattle in the winter, you would make this country very productive?

Mr. WHELPLEY. Certainly.

The CHAIRMAN. Have you ever been in any region that would be better for that purpose than this?

Mr. WHELPLEY. Never.

The CHAIRMAN. Are there many new enterprises for irrigation being set on foot now?

Mr. WHELPLEY. Not for irrigation, that I know of, in this neighborhood. I believe there is a company formed for taking a ditch out of the 'Spring Creek,' which I spoke of. It takes a week to make that big 'Spring Creek' rise, and it never falls very low. It is never dry in summer, but the settlers along it are mostly half-breeds. The white people have been chary about going in there.

The CHAIRMAN. Would a survey which would show where reservoirs,

ditches, and other hydraulic works could be constructed to advantage, and which would also show what land could be irrigated and the cost of irrigating it, be a benefit to this country?

Mr. WHELPLEY. A very great benefit.

The CHAIRMAN. Would there be many places where irrigation is not now practiced that would be developed, in your opinion, and where a few people could do it?

Mr. WHELPLEY. I think very few places. There are few places in this part of the country where a few people could do much of anything of that character.

The CHAIRMAN. It requires large capital?

Mr. WHELPLEY. It requires large capital.

The CHAIRMAN. Has much attention been paid to the storing of water in small places in this neighborhood?

Mr. WHELPLEY. None to speak of.

The CHAIRMAN. What effect would the cutting of timber have on these streams?

Mr. WHELPLEY. The cutting of the timber helps to dry up the streams, and decreases the opportunity for the storage of water.

The CHAIRMAN. Has the timber been cut off much in this vicinity?

Mr. WHELPLEY. It is being rapidly taken from the mountains of the Judith Basin.

The CHAIRMAN. For what purposes?

Mr. WHELPLEY. For domestic purposes.

The CHAIRMAN. Have you been troubled with forest fires?

Mr. WHELPLEY. Large patches have been burned not far from here. The fire goes along the ground, and it affects the trees, and even though they do not fall down, they are injured very materially. They sometimes stand for years, however, and help to hold water.

The CHAIRMAN. What precautions might be taken by the Government to preserve this timber and at the same time allow a reasonable quantity to be taken off for domestic purposes and mining?

Mr. WHELPLEY. Of course, I have not given thought to those questions. I am only answering on the spur of the moment. The only way, I think, is to have a timber inspector, and allow only a certain growth of timber to be taken.

The CHAIRMAN. Is the present system of secret agents satisfactory to the people?

Mr. WHELPLEY. The people fight against the secret agent on the principle that they are free American citizens, and do not like that sort of thing. So far as I am concerned, I do not see that your secret service has saved any of our timber. The timber goes just the same.

The CHAIRMAN. What effect does it have on the people to have secret agents here arresting them?

Mr. WHELPLEY. It creates a combination among the ranchers, as you may say, to defeat the secret service. It is a sort of agreement that they should protect each other and have what they want.

The CHAIRMAN. If you had a local agent who was a citizen here, whom everybody knew, and if he made reasonable arrangements, would the people comply with those arrangements?

Mr. WHELPLEY. Certainly they would. If a proper man had ample authority, and was appointed with some regard to his qualifications for the office, of course the people would recognize the reasonableness of the situation. Much would depend on the man; but I think if the right man were appointed his word would be regarded.

The CHAIRMAN. The people who live here desire the timber to be preserved, I suppose?

Mr. WHELPLEY. They all see the necessity of it.

The CHAIRMAN. The secret agents do not do any good towards stopping its destruction, do they?

Mr. WHELPLEY. In my opinion they do not.

The CHAIRMAN. Would you then recommend a division of the country into timber districts, and the appointment of reasonable men to see that the arrangements were carried?

Mr. WHELPLEY. Yes; a timber inspector who would say what age or growth of timber should be cut and what should not would be a very desirable officer. There is certain timber that would be better taken out. I think the secret agents are probably doing some good in checking the wholesale destruction by saw-mills, and so on, of the timber we have left. That would not come under my observation, but they may be doing good in that way. The ranchers have to have timber.

The CHAIRMAN. And with proper regulations they could have it without denuding the hills?

Mr. WHELPLEY. Certainly they could.

The CHAIRMAN. Do you not think that denuding the hills of timber would be a great detriment to agriculture?

Mr. WHELPLEY. I think it would be the ruination of agriculture. I wish to say, before getting through, that the Little Belt Mountains will make a great water storage place. There is a fine forest there, but it is gradually becoming worked into by the ranchers.

We got information last week that the Judith River was lower than it had ever been in the history of the country. There are two big ditches running out in the basin above Utica. The Yellowstone is about the only river where the water is not fully occupied. Park County is not so much interested as other counties in irrigation. We have not the same extent of arable land, and we have a good deal of mountain. We have large masses of low grade ore about the Yellowstone that we can not get into.

Adjourned.

BOZEMAN, MONT., *August 8, 1889.*

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF JOHN WILLIAMS.

The CHAIRMAN. Where do you reside?

Mr. WILLIAMS. On the West Gallatin.

The CHAIRMAN. How long have you resided there?

Mr. WILLIAMS. Since 1869.

The CHAIRMAN. What is your occupation?

Mr. WILLIAMS. Farming and stock raising.

The CHAIRMAN. Have you given attention to the subject of irrigation?

Mr. WILLIAMS. Yes.

The CHAIRMAN. What can you say of its results; what effect has it produced in crops?

Mr. WILLIAMS. The fact is, I do not think we could raise a crop here without irrigation.

The CHAIRMAN. Irrigation is a necessity here, then ?

Mr. WILLIAMS. Yes.

The CHAIRMAN. With irrigation what kind of crops can you raise ?

Mr. WILLIAMS. We can raise good crops, I call them ; better than we raise in the East.

The CHAIRMAN. Have you farmed in other countries ?

Mr. WILLIAMS. Yes ; in Missouri.

The CHAIRMAN. How do the products of a farm here, taking a period of ten years, compare with the products of the best farms in Missouri ?

Mr. WILLIAMS. The small grain—that is what I raise here—is about double what I have raised in Missouri.

The CHAIRMAN. Do you have any failures of crops where you irrigate ?

Mr. WILLIAMS. Very seldom. In some locations the frosts hurt crops ; but that is very seldom.

The CHAIRMAN. How is it with other crops besides small grain ? How do they succeed ?

Mr. WILLIAMS. What kind do you mean—corn ?

The CHAIRMAN. Corn, potatoes, and so on.

Mr. WILLIAMS. We raise large crops of potatoes here.

The CHAIRMAN. How many bushels of potatoes do you raise to the acre ? What is a fair crop ?

Mr. WILLIAMS. I have raised at the rate of 400 bushels to the acre ; may be more.

The CHAIRMAN. What do you say as to the expense of farming by means of irrigation as compared with other kinds of farming ?

Mr. WILLIAMS. The expense is somewhat more, of course. I suppose that it costs about 50 cents per acre a year to irrigate the ground once ; but sometimes we have to irrigate twice. We have had to do that this year.

The CHAIRMAN. Then it has cost you \$1 a year ?

Mr. WILLIAMS. Yes.

The CHAIRMAN. Have you raised alfalfa here ?

Mr. WILLIAMS. No ; I have not.

The CHAIRMAN. Have you seen it raised ?

Mr. WILLIAMS. Yes.

The CHAIRMAN. How does it succeed ?

Mr. WILLIAMS. That which I noticed did not succeed very well on account of the ground being too wet. The alfalfa was sown on a damp heavy soil, what we call meadow lands here.

The CHAIRMAN. How well are you acquainted with the general country around the eastern part of Montana ?

Mr. WILLIAMS. I am better acquainted with the Lewis and Clarke, Madison, and Gallatin Valleys.

The CHAIRMAN. Which one of those counties has the most land that can be irrigated ?

Mr. WILLIAMS. Gallatin County, I think.

The CHAIRMAN. What extent of land is there in this county on which you could get water ?

Mr. WILLIAMS. That is hard to state.

The CHAIRMAN. Of course you can not tell accurately. But it is very large, is it not ?

Mr. WILLIAMS. Yes, it is. There is a large amount of land which could be watered here where no water has been put as yet.

STATEMENT OF DAVID DAVIS.

The CHAIRMAN. Where do you reside?

Mr. DAVIS. Twelve miles down the East Gallatin.

The CHAIRMAN. What is your occupation?

Mr. DAVIS. Farming.

The CHAIRMAN. Do you irrigate your land?

Mr. DAVIS. Yes; that is, part of it, and on part of it I have no water.

The CHAIRMAN. On that part which you have watered, what success have you met with in raising crops?

Mr. DAVIS. We raise about double the other crop.

The CHAIRMAN. Have you ever farmed in any other country?

Mr. DAVIS. No; I was a boy when I came here.

The CHAIRMAN. On irrigated land, what do you call a fair crop of oats?

Mr. DAVIS. Fifty or 60 bushels to the acre, although I have raised 75. But I will call 50 or 60 bushels a fair crop.

The CHAIRMAN. Have you raised any wheat?

Mr. DAVIS. Yes.

The CHAIRMAN. How much wheat have you raised to the acre?

Mr. DAVIS. On irrigated land 40 bushels to the acre. This season, if my crop goes 15 bushels to the acre on unirrigated land, I will be satisfied.

The CHAIRMAN. You have irrigated some, have you not?

Mr. DAVIS. Not the wheat, only oats.

The CHAIRMAN. Have you raised any barley?

Mr. DAVIS. We had 50 acres in barley, but none of it was saved.

The CHAIRMAN. Why? Because you had no water?

Mr. DAVIS. Yes.

The CHAIRMAN. Have you tried raising other crops besides small grain?

Mr. DAVIS. No.

The CHAIRMAN. Not garden truck—potatoes and so on?

Mr. DAVIS. Yes, potatoes, turnips, and such truck as that.

The CHAIRMAN. How do they prosper?

Mr. DAVIS. This country is good for potatoes.

The CHAIRMAN. What kind of hay do you raise?

Mr. DAVIS. Timothy hay.

The CHAIRMAN. That is the hay generally raised in the valley, is it not?

Mr. DAVIS. Yes; there is some clover raised, but I have not raised any myself.

The CHAIRMAN. You have not tried alfalfa?

Mr. DAVIS. No.

The CHAIRMAN. What do you regard as a good crop of timothy hay on irrigated land?

Mr. DAVIS. They have raised as high as three tons to the acre.

The CHAIRMAN. One cutting?

Mr. DAVIS. Yes.

The CHAIRMAN. What would be an average crop?

Mr. DAVIS. My crop this season would not go over a ton to the acre. It was not irrigated.

The CHAIRMAN. You can do something without irrigation here.

Mr. DAVIS. Yes.

Senator REAGAN. It was mentioned that you might have to irrigate land once or twice. Which is the more common?

Mr. DAVIS. The amount differs.

Mr. REAGAN. Then it depends on the character of the land?

Mr. DAVIS. Take the upland, and in a season like this it would need irrigation twice.

Senator REAGAN. At what season of the year do you usually irrigate?

Mr. DAVIS. I always commence about the 4th of July; but this season I ought to have commenced the 4th of June. I commenced the 10th or 12th, but I should have commenced eight days sooner.

Senator REAGAN. When do you plant your oats?

Mr. DAVIS. In April or May.

Senator REAGAN. This year you thought it best to commence in June?

Mr. DAVIS. Yes. Of course, we usually calculate on June rains; but this year we did not have them.

Senator REAGAN. At what stage of the crop do you put water on the land?

Mr. DAVIS. It is best when the grain gets up to shade the land, high enough to have little roots to hold the soil. When the grain is too short the water washes the soil from the roots.

The CHAIRMAN. How do you irrigate—by flooding the land?

Mr. DAVIS. Yes.

The CHAIRMAN. How long do you allow the water to stay on the land?

Mr. DAVIS. Well, there again there is a difference in regard to the land. Take the upland, there is a good deal of fall, and it is running from one ditch to another. You make your ditches 10 to 12 feet apart, and you keep the water running well.

STATEMENT OF T. L. LUCE, OF NORTH.

The CHAIRMAN. Where do you reside?

Mr. LUCE. About 4 miles from town here at North.

The CHAIRMAN. What is your occupation?

Mr. LUCE. Farming.

The CHAIRMAN. Have you practiced irrigation?

Mr. LUCE. I do where I can.

The CHAIRMAN. So far as your experience has gone, what is the result of irrigation in producing crops in this valley?

Mr. LUCE. My experience is that it is one-half more where there is irrigation than where there is no irrigation.

The CHAIRMAN. What State were you from originally?

Mr. LUCE. Vermont.

The CHAIRMAN. How would an irrigated farm here compare in productiveness with a farm of the best land in Vermont?

Mr. LUCE. The land here would be far ahead of the land in Vermont.

The CHAIRMAN. One acre of land here would be equal to how many acres in Vermont?

Mr. LUCE. Well, I do not know, as far as that is concerned—perhaps three acres.

The CHAIRMAN. That is to say, if a farm in Vermont would have good crops, a farm of irrigated land here would have an average of three times the crop of the farm in Vermont?

Mr. LUCE. Just about three times.

The CHAIRMAN. What is a fair crop of oats in this valley?

Mr. LUCE. I do not know that I can answer that question.

The CHAIRMAN. How many bushels of oats have been raised to the acre in this valley ?

Mr. LUCE. I have raised 80 bushels to the acre.

The CHAIRMAN. Did you ever raise any wheat ?

Mr. LUCE. Very little.

The CHAIRMAN. There has been some wheat raised in the valley, has there not ?

Mr. LUCE. Oh, yes.

The CHAIRMAN. How many bushels, where it is well cultivated ?

Mr. LUCE. From 40 to 70 bushels to the acre.

The CHAIRMAN. How long have you been farming here ?

Mr. LUCE. Eleven years on the place where I am now.

The CHAIRMAN. Does the land deteriorate or produce about the same crops from year to year ?

Mr. LUCE. It remains the same.

The CHAIRMAN. And cropped every year ?

Mr. LUCE. Yes.

The CHAIRMAN. After 11 years of cropping all over, does the land produce as heavy a crop as it did when you commenced ?

Mr. LUCE. Yes, a little more.

The CHAIRMAN. Do you know of any farm in the valley where, by cropping, it produces less ?

Mr. LUCE. Yes, there are farms.

The CHAIRMAN. Where they are irrigated ?

Mr. LUCE. I think where they are irrigated.

The CHAIRMAN. How do you account for that ?

Mr. LUCE. Well, it is from the lightness of the soil.

The CHAIRMAN. I suppose you can raise small fruits in the valley ?

Mr. LUCE. Yes; berries can be raised.

The CHAIRMAN. Have you ever tried any of the larger fruits, such as apples ?

Mr. LUCE. No; I have not.

The CHAIRMAN. Have not some of your neighbors tried them ?

Mr. LUCE. No.

STATEMENT OF W. W. ALDERSON, OF BOZEMAN.

The CHAIRMAN. What is your occupation ?

Mr. ALDERSON. I am a newspaper man at present.

The CHAIRMAN. You are the editor of what paper ?

Mr. ALDERSON. The Avant Courier.

The CHAIRMAN. How long has that paper been established ?

Mr. ALDERSON. Between seventeen and eighteen years.

The CHAIRMAN. How long have you resided in this valley ?

Mr. ALDERSON. I have been in the valley twenty-five years; I came here in 1864.

The CHAIRMAN. Have you taken an interest in irrigation ?

Mr. ALDERSON. Yes. I was a practical farmer, and I am a dairyman, and have been for twelve years.

The CHAIRMAN. What can you say as to the effect of farming by means of irrigation ?

Mr. ALDERSON. As to crops it is an absolute necessity in most of the locations in Montana. There are locations close to the streams, and in the lowest ground where indifferent crops can be raised without irrigation. But I think the most favorable ground can be improved by

irrigation. That has been my experience. I have a farm within a mile of this place. I have some crops there, though not favorable. There was some difference in the depth of the soil.

The CHAIRMAN. Then irrigation here may be regarded as a necessity?

Mr. ALDERSON. It is a necessity.

The CHAIRMAN. What can you say of the crops produced by irrigation? What is the average crop of oats where the land is well cultivated?

Mr. ALDERSON. The crops of this country are superior to any I have seen in any locality, and I have resided in Illinois, Wisconsin, and Minnesota. Of course, I have traveled in other States. I know the yield generally produced in most of the States; and I think, with irrigation in the Gallatin Valley—of course I am better acquainted here than anywhere else—the crops exceed anything that I have ever seen.

The CHAIRMAN. And you generally raise crops; that is to say, you have no failures?

Mr. ALDERSON. We have no failures. We have had crops injured some by early frosts in fall; but it was generally where crops were planted late in spring, and, perhaps, irrigated too late. In early years, on account of our want of experience in irrigation, we sometimes suffered some loss of crops; but it was on account of the late sowing or too late irrigating.

The CHAIRMAN. Then with proper management of a farm you can by irrigation produce a crop every year?

Mr. ALDERSON. Yes. We have had no failures here—nothing like a general failure.

The CHAIRMAN. What do you say of the effect of continuous cropping here?

Mr. ALDERSON. There seems to be no diminution of the crops. This year has been unusually dry, and the water has been scarce; but the crops last year were just as heavy on the same land that has been cultivated for twenty years as they were in the early years.

The CHAIRMAN. Do you produce generally as good crops as we saw to-day?

Mr. ALDERSON. Yes. Those crops are on pretty moist land. They do not generally resort to irrigation here until rather late in the season, and a great many of them did not prepare for the unusual drought that we had. They generally commence irrigating about the latter part of June or the first of July, and the crops needed irrigation sooner this year.

The CHAIRMAN. What is an average crop of oats where the ground is well prepared and well cultivated and irrigated?

Mr. ALDERSON. The oats run from 50 to 100 bushels to the acre. I should think that an average crop, where the ground is properly cultivated and irrigated, would be 75 bushels to the acre.

The CHAIRMAN. How much of wheat?

Mr. ALDERSON. Wheat would be about 40 bushels to the acre.

The CHAIRMAN. Would it average that?

Mr. ALDERSON. Perhaps 40 bushels is a pretty high average. But it seems to me that it can not run short of that. A great many crops run from 50 to 60 bushels to the acre. The wheat that we raise here is soft wheat; the white hard wheat would run lower than that—25 bushels to the acre. They tell me that by continual cultivation and irrigation the hard wheat will become soft. I presume that is the case. That is what I have been informed by farmers and mill men.

The CHAIRMAN. You are generally somewhat familiar with Montana?

Mr. ALDERSON. Yes, I have been over part of the Territory.

The CHAIRMAN. What do you say as to the Territory generally? Is it well supplied with water?

Mr. ALDERSON. Yes; it is a well-watered country. This valley is better supplied, perhaps, than the balance.

The CHAIRMAN. Are you using the full supply of water which you have in the river here?

Mr. ALDERSON. This stream here is taken out at a place on Mill Creek between here and West Gallatin, during the irrigating season. But there is some water in West Gallatin that is not appropriated. There is only a small portion of the arable land in the valley that is under cultivation.

The CHAIRMAN. Is there any opportunity for increasing the supply of water by storing it?

Mr. ALDERSON. Yes; there is a splendid opportunity at the head of this stream, at what is called Mystic Lake. There is a lake up there, and an excellent opportunity to construct a dam, at a reasonable cost, to store almost any amount of water. There is a good deal of water, from the melting of the snows in the spring, which runs to waste, and it is at a time when they are not irrigating that the water runs away.

The CHAIRMAN. What proportion of the valley is under cultivation compared with the whole; that is, good arable land if it had water?

Mr. ALDERSON. Not to exceed one-fourth.

The CHAIRMAN. What is the value of the land that is improved and under irrigation?

Mr. ALDERSON. Farms have been sold here for from \$12 to \$25 an acre; in some instances perhaps a little higher. It depends on their location as to the town and the water range.

The CHAIRMAN. What has been the expense per acre of procuring water? Can you estimate that?

Mr. ALDERSON. No, I have never figured on that. Nearly all the water has been brought out by private parties, by two or three farmers operating together until this last enterprise, the West Gallatin ditch, which was completed last summer. That was undertaken by two or three farmers in the first place, but they failed to carry it through.

The CHAIRMAN. What is the size of that ditch?

Mr. ALDERSON. That is 24 feet, I think.

The CHAIRMAN. Twenty-four feet on the bottom?

Mr. ALDERSON. I am not certain of that—whether it is 24 feet on the bottom or on the top. I have just been informed that it is 24 feet on the top and 16 feet on the bottom.

The CHAIRMAN. What is the length of the ditch?

Mr. ALDERSON. About 20 miles.

The CHAIRMAN. What did it cost to construct such a ditch as that?

Mr. ALDERSON. They variously estimate it at from \$35,000 to \$80,000.

The CHAIRMAN. About how much land will it irrigate?

Mr. ALDERSON. They claim to have sufficient water for 50 farms of 160 acres each. They have a way of estimating the number of inches required for each acre.

The CHAIRMAN. How much more expensive is it to farm by irrigation after you have the water than it is where you have rain-fall?

Mr. ALDERSON. It used to cost me for irrigating about \$1 a year per acre.

The CHAIRMAN. You irrigated twice?

Mr. ALDERSON. Yes, twice, I used to estimate the cost at 75 cents

for irrigating once. But that, of course, included the ditches. When the ditches are all fixed and prepared it is comparatively a small job.

The CHAIRMAN. How many inhabitants have you in this county?

Mr. ALDERSON. We have no way of telling except by the vote that is cast at the general elections. We cast about 1,600 votes, and we estimate four persons to each voter. That would give the population I should think. Of course, we are a community of homes and families here in this county—emphatically so, because in a farming community we have no other interests.

The CHAIRMAN. Where do you have a market for your products?

Mr. ALDERSON. We find a market for our products in the mining camps at Helena, Butte, Anaconda, Phillipsburgh, and New Chicago. We ship some grain down the Yellowstone. We now ship barley to Milwaukee and St. Paul. By the way, we raise a superior quality of barley.

The CHAIRMAN. What do you say of this country as a stock country?

Mr. ALDERSON. This is a splendid stock country. We have pretty deep snows in the winter, and the stock is kept in bands. Each farmer has little bands. They run out on the hills in summer and in winter are fed in the valley. The lands in the foot-hills make splendid pasture lands.

The CHAIRMAN. There are lands in this valley that are yet unoccupied?

Mr. ALDERSON. Yes; some land owned by the railroad company. But there is still considerable unoccupied Government land without any water facilities.

The CHAIRMAN. Would surveys by the Government, indicating what land could be irrigated, giving the lines and ditches, setting apart places for reservoirs, and estimating the cost of the construction of the works, be useful to the people here?

Mr. ALDERSON. I should think so. I think the benefit would be incalculable, because there is no expenditure of money that can exceed the results of irrigation in the way of crops. That has been the result of my observation and experience.

The CHAIRMAN. You are aware of the acts that have been passed by Congress. The first, in the first session of the last Congress, appropriated \$100,000 to survey the places that the Government might select as reservoir sites. A provision was made for reserving from settlement, sale, and occupation all lands so reserved. At the second session there was appropriated \$250,000 more for surveys, and the work has already been begun. Now, would the prosecution of that work facilitate the settlement of the country? If the people knew the lands that could be irrigated and the expense that would attach, would they combine to construct the ditches in many cases or get capital to do it?

Mr. ALDERSON. There has been the difficulty, and it is the difficulty now. You see for six or eight years the farmers here attempted to construct this canal but failed. Finally it was taken up by a few capitalists in Illinois, and they had all they wanted to do. If the old settlers can not construct those expensive ditches, of course new settlers can not. Those that are here now are pretty well fixed—in good circumstances. But they have secured their water rights.

The CHAIRMAN. And additional water could be stored in a good many instances, I presume?

Mr. ALDERSON. Even then it would require a good deal of expense to take out the ditches from the body of those streams.

The CHAIRMAN. There are a good many places where they would have the opportunity.

Mr. ALDERSON. Yes; a good many places. If the idea is to redeem the country and bring it under cultivation, take the bench land on the West Gallatin River. There is a strip of country 30 miles long and it is fertile. But it would be expensive taking out water, and there are no two or half dozen farmers, under ordinary circumstances, who could accomplish that. It will perhaps be done by a corporation, a stock company, just as this ditch here was constructed.

The CHAIRMAN. Have you ever tried the plan of forming a corporation and issuing stock to the parties owning the land and allowing them to control the corporation; has that been tried?

Mr. ALDERSON. That has been tried in certain instances. That is the case with this West Gallatin ditch.

The CHAIRMAN. Do you generally have the land and water owned by the same person, or do they buy the water?

Mr. ALDERSON. They do not go together. This is the first instance where the farmers have the opportunity of purchasing the water—that is, in this valley.

The CHAIRMAN. Have they any contract whereby they can get the water, or is it under the control of the corporation so that it can take the water away from the farmers?

Mr. ALDERSON. No; I think the farmer has a contract with the company that extends for a number of years. The water belongs to the farmer. I know that when I sold my farm here, the water right went with it.

The CHAIRMAN. Have you observed the effect of cutting the trees off the water-courses?

Mr. ALDERSON. We have not observed it here. There has been so little timber cutting here that I do not think it has perceptibly affected anything. There has been no timber cut except down toward the foothills.

The CHAIRMAN. Have there been any forest fires?

Mr. ALDERSON. There are some forest fires, but they have not been serious around this county.

The CHAIRMAN. You are familiar with the whole Territory, are you not?

Mr. ALDERSON. Yes. They have had some pretty severe fires on the west range of the Rocky Mountains, between here and Missoula, and they have had some pretty heavy forest fires up in the National Park.

The CHAIRMAN. Has there been any observation here of the best mode of letting the people have what timber they require and then preserving the forest as much as possible?

Mr. ALDERSON. It has been talked of, but there has been no action taken by the community in regard to it. There should be some arrangement.

The CHAIRMAN. How does this system of secret agents representing the Government operate?

Mr. ALDERSON. So far as I know it has never resulted in any particular benefit either one way or the other.

The CHAIRMAN. What would you think of substituting for these secret agents, timber agents or inspectors appointed from the different communities—agents whom the citizens in the different localities all knew?

Mr. ALDERSON. I think that would be an excellent plan. Every-

body would know the man who was placed in that vicinity, and his authority and advice and instructions would be respected.

The CHAIRMAN. The people, you think, would be in favor of that system if they were fairly dealt with and consulted about it?

Mr. ALDERSON. Yes; that is my idea.

The CHAIRMAN. What do you think of selling the public land—land that is not fit for agricultural purposes? Would it not be as well for the Government to keep it and let the people cut the timber by paying a suitable price?

Mr. ALDERSON. I think it would be best for the Government to retain control.

The CHAIRMAN. And permit the people to cut the timber and take away the dead stuff?

Mr. ALDERSON. Yes; but to preserve sufficient timber to hold the snow and moisture.

The CHAIRMAN. Have you not in sections observed how the timber has affected the streams?

Mr. ALDERSON. No, I have not.

The CHAIRMAN. You know as a fact that the timber does preserve the snow?

Mr. ALDERSON. It must, as a necessity. Of course I have observed that. If there were any danger of the timber being taken off the mountains here, it would be a serious question with us.

The CHAIRMAN. Is there not danger from forest fires?

Mr. ALDERSON. Yes, that is a great danger to us. The timber in this vicinity will grow as fast as it is used.

The CHAIRMAN. Do you, in the measurement of grain, estimate by the weight or by bushels?

Mr. ALDERSON. We measure all the grain. But when we sell, the custom has prevailed of selling oats and barley by the hundredweight. Heretofore wheat has been sold by the bushel—60 pounds to the bushel.

The CHAIRMAN. How does the wheat that is grown here compare with that of other countries?

Mr. ALDERSON. It is heavier than it is in Illinois, Wisconsin, and Minnesota.

The CHAIRMAN. How much heavier is it here?

Mr. ALDERSON. It is from one fifth to one-quarter heavier. I think it will average one-fourth heavier than in what used to be called the Northwestern States.

Director POWELL. Have you taken out the water so that the question of water-rights has become to be of interest?

Mr. ALDERSON. Yes. It has come to be a pretty fixed question in regard to the small streams, East Gallatin, Bozeman, and Meadow Creeks. Of course the water is claimed, but there is quite a number that can not be supplied. The old claims have come to be disregarded by parties settling up the streams at the base of the mountains and they get the first chance at the water. It occurs every season that the older settlers are deprived entirely of their rights, and of course it has led to a great deal of quarreling, and in some cases very serious quarreling—shooting and killing.

STATEMENT OF T. C. BURNS, OF MILK RIVER

The CHAIRMAN. Have you ever farmed in this valley?

Mr. BURNS. No. But I lived in the vicinity, 60 miles east of here. I lived on one farm for ten years, 30 miles east of Livingstone.

The CHAIRMAN. On the Yellowstone?

Mr. BURNS. Yes.

The CHAIRMAN. Did you farm by irrigation there?

Mr. BURNS. Yes.

The CHAIRMAN. With what success?

Mr. BURNS. Very good success usually.

The CHAIRMAN. What kind of crops did you farm there?

Mr. BURNS. Wheat, oats, vegetables, and hay.

The CHAIRMAN. What was an average crop of wheat there?

Mr. BURNS. Not a great deal of wheat had ever been sowed there. At least we never sowed enough except for our own use. It was not handy to the mills. Oats were preferable on that account. I suppose the yield would be something like the yield here.

The CHAIRMAN. The condition would be about the same?

Mr. BURNS. Yes.

The CHAIRMAN. Is the land about the same?

Mr. BURNS. No. I think the land about here is a little better. The soil is not so deep there as a rule as it is in this valley.

The CHAIRMAN. What is a fair average crop of oats where you were?

Mr. BURNS. I should say 40 or 50 bushels.

The CHAIRMAN. Describe the place north, at which you now reside?

Mr. BURNS. It is known as the New Reserve, that was opened a year ago.

The CHAIRMAN. How far north is it?

Mr. BURNS. About 200 miles north perhaps. It is 340 miles by railroad from there to Helena.

The CHAIRMAN. How near to the Canadian line is it?

Mr. BURNS. Within about 40 miles—the settlement I speak of.

The CHAIRMAN. What irrigation have they had there?

Mr. BURNS. Nothing until the present season, except what the Government has done at the Indian agency and at Fort Sanborne. I believe there has been something in the way of a garden irrigated at Fort Sanborne, but nothing to speak of.

The CHAIRMAN. Do they irrigate there this season?

Mr. BURNS. Many of them do. Many settlers have been induced to come in there from the East by the railroad companies, which would not as lief the people would not irrigate. The result is that they have all been fooled.

The CHAIRMAN. It is a pretty hard thing to bring them in here and teach them that, is it not?

Mr. BURNS. I think the settlers have come to that conclusion. The railroad company has even gone further than that.

The CHAIRMAN. What railroad company?

Mr. BURNS. The St. Paul, Minneapolis and Manitoba road. They induced settlers to come in there by issuing certain pamphlets saying it was a mild climate and that they would not have to irrigate. Seeing that they did require to irrigate the farmers went to work and constructed ditches, and about the time the farmers were ready to use the water the railroad company procured papers from the court enjoining

them from using the water, because they would cause their tanks along the road to go dry.

The CHAIRMAN. Is there an opportunity to irrigate in that region?

Mr. BURNS. There is, to a certain extent, although water is not so plentiful there as in other portions of the country. I do not doubt, however, that we could get water by storage and making lakes, and so forth.

The CHAIRMAN. Have you traveled over the country with a view to seeing whether water could be stored or saved?

Mr. BURNS. No; I have not. I understand though that there are a number of lakes on the bench lands and on the high lands.

The CHAIRMAN. Is the soil very good there?

Mr. BURNS. Yes.

STATEMENT OF P. W. KOCH, OF BOZEMAN.

The CHAIRMAN. How long have you resided in Bozeman?

Mr. KOCH. Nearly twenty years.

The CHAIRMAN. What is your occupation?

Mr. KOCH. I am a bank cashier.

The CHAIRMAN. Are you familiar with this country, and have you traveled over it?

Mr. KOCH. Yes.

The CHAIRMAN. Have you ever been engaged in any other business except as cashier of the bank here?

Mr. KOCH. Yes. I have been engaged in land surveying, in Indian trading, and in mercantile pursuits of different kinds.

The CHAIRMAN. Then I understand you are a civil engineer also?

Mr. KOCH. Yes.

The CHAIRMAN. Have you surveyed a good deal of land in this section?

Mr. KOCH. Yes. Some on this side, but more on the west side; on the Pacific Slope; in the western part of the Territory.

The CHAIRMAN. Have you observed the effect of irrigation on different parts of the Territory?

Mr. KOCH. Yes.

The CHAIRMAN. Is it regarded as a necessity in this Territory?

Mr. KOCH. It is in most cases, with the exception of some bench lands in the immediate vicinity of the mountains, where winter-wheat can be raised without irrigation. It is an absolute necessity everywhere else. The bench lands where the snow lies thick in the winter seems to hold enough moisture, but in the main valleys irrigation is absolutely necessary, in most years.

The CHAIRMAN. What do you think of the effect of irrigation in producing crops?

Mr. KOCH. I never saw such crops in any other country as are raised here by irrigation. Our average of crop here is at least double that in any other State in the United States where they have not irrigated.

The CHAIRMAN. You get a good crop?

Mr. KOCH. Excellent.

The CHAIRMAN. This has been an unusually dry year, has it not?

Mr. KOCH. The dryest I have seen since I have been in Montana. I have kept a record ever since I have been here.

The CHAIRMAN. What proportion of the land could be irrigated if all the appliances for saving water were used?

Mr. KOCH. The question is simply whether the bench lands along

the lower course of the Yellowstone and Missouri are of sufficiently low elevation to utilize the water in those streams.

The CHAIRMAN. What, in your opinion as an engineer, is the proportion that could be irrigated? You have passed over it, though you may not have used instruments upon it.

Mr. KOCH. I think the amount of cultivated land in Montana will be ultimately limited by the question of water. Of course, that is not counting the west side of Montana—the Pacific slope—because there a comparatively slight part of the country is adapted to irrigation.

The CHAIRMAN. You are limited to the water running in the streams. Does not the largest proportion of the water go to waste?

Mr. KOCH. Yes. The time for irrigation comes after the highest stage of water in the river has passed away. The highest stage of water in the river here is in June and early in July, and the irrigation season does not begin until July.

The CHAIRMAN. Could not a large portion of that water be saved above by reservoirs?

Mr. KOCH. Yes. I do not believe that any country is better adapted for reservoirs than this. As you go along you find a number of lake-beds, and where the lake-beds are you very generally find a gentle current. Below the outlet of those lake-beds there are always narrow cañons, so that it would be comparatively an easy matter to construct dams.

The CHAIRMAN. Then, a good deal of water might be kept back with no very great expense?

Mr. KOCH. Yes. I believe that in many of these streams the amount of water might be doubled at comparatively little expense.

The CHAIRMAN. I have traveled over the mountains a good deal myself, and I find what you say to be true all through the mountain regions. That would be cheaper than litigation, would it not?

Mr. KOCH. A good deal cheaper.

The CHAIRMAN. The law now reserves all places that may be designated by the Geological Survey for the storage of waters. Do you think that is wise?

Mr. KOCH. Yes.

The CHAIRMAN. What would you say, then, of the advantage of a survey which would designate those places where water could be stored, and which would indicate the cost and the other items of information necessary to enable the people to judge of the feasibility of the work?

Mr. KOCH. It would be a very great advantage. The maps of the Geological Survey are of great assistance in regard to our Territory here. I thought I knew everything about this country, but from studying those maps I learned more than I ever did before. I succeeded after great difficulty in securing those maps—and, by the way, it seems to me a great misfortune that those maps are not obtainable by the general public.

The CHAIRMAN. Would it not be practicable for settlers themselves to unite and construct many works of irrigation throughout a large portion of the country without these very expensive investments?

Mr. KOCH. Certainly it would.

The CHAIRMAN. You think that the surveys and estimates of costs would do much good and enable people to avail themselves of the most desirable places?

Mr. KOCH. Yes.

The CHAIRMAN. It is very difficult for a settler, is it not, to come here and ascertain the cost, and then get others to help him to build

ditches, especially if the others do not believe in the efficacy of irrigation?

Mr. KOCH. It is impossible for a settler to do it. It is impossible for a person to be convinced of the benefits of irrigation unless he sees them. Unless one makes a study of it he will never realize the amount of land that may be reclaimed by a canal drawn from the mountains. You can take an instance of it right over here. There is a stream called Middle Creek in this valley, which, next to the Gallatin, is most relied upon for irrigating purposes. There have been a dozen suits in which several hundred people are interested, that have been instituted this year. I believe that \$5,000 judiciously expended up there will double the water available for irrigating purposes. There will be a good deal of money spent in those suits, and between the lawyers' fees and the costs they will involve considerable expense to the parties concerned.

The CHAIRMAN. A suit to determine water rights settles nothing. If A sues B, when he gets through, he recovers nothing. The only good done is that they are called in. Their claims are brought up and recorded.

Mr. KOCH. Yes. In every one of those cases there are from twenty to thirty defendants.

The CHAIRMAN. Then if you can irrigate the bench lands, as you think you can, by saving the water, the amount of arable land is very large?

Mr. KOCH. Yes. You take the northern and eastern part of Montana and it is nearly all a rolling prairie country. It would be all available for agriculture, or at least the greater part of it, if it could be irrigated.

The CHAIRMAN. What proportion?

Mr. KOCH. It is difficult to say. I believe that over one-half of the area of Montana is certainly capable of successful agriculture if it had water. I think that any one familiar with the eastern and northern part of the Territory will support me in that. Of course here in the mountains that is not so.

The CHAIRMAN. Would not the remainder of the land that could not be irrigated furnish good summer feed for stock?

Mr. KOCH. Yes.

The CHAIRMAN. All over the State?

Mr. KOCH. Yes, except the very high mountainous portions.

STATEMENT OF ENOCH HODSON, OF BOZEMAN.

The CHAIRMAN. Are you engaged in the timber business?

Mr. HODSON. I have been running a saw-mill for eight years, and making more or less ties for railroads.

The CHAIRMAN. Are you cutting the timber on the Government land?

Mr. HODSON. I suppose so. However, I do not know where the railroad land begins or the Government land ends.

The CHAIRMAN. Are they destroying timber pretty badly through here?

Mr. HODSON. Not in this vicinity.

The CHAIRMAN. Are they in any place in Montana?

Mr. HODSON. I have seen places where they did such things.

The CHAIRMAN. Is there any arrangement to preserve the undergrowth and preserve the timber from fire?

Mr. HODSON. No.

The CHAIRMAN. What is the Government regulation here, and how is it carried out?

Mr. HODSON. They make examples of a few individuals against whom somebody happens to have a spite, and they fight them to make themselves "solid" with the powers that be, so that they can hold their own positions. That is all that has ever been known of it in Montana. There has not been anything done for the benefit of the general public.

The CHAIRMAN. Suppose there was a responsible timber agent here who would make regulations to preserve the undergrowth and prevent the forest fires, and, generally, to aid in the preservation of the timber, would the people readily comply with all reasonable regulations on his part?

Mr. HODSON. I think they would. They are all interested in the preservation of the timber, and they would assist him, I think.

The CHAIRMAN. By the present system there is a good deal of timber being destroyed by fire and otherwise?

Mr. HODSON. Yes, by fire more than by any other cause; but it is not on account of any lack of interest on the part of the timber men.

The CHAIRMAN. But you would all rather be put under regulations and watched by somebody whom you knew in the neighborhood, and who was responsible, than to have secret agents coming among you?

Mr. HODSON. I certainly would most readily and cheerfully accede to any regulations of such an officer. I have no use for secret agents.

The CHAIRMAN. You will all have to unite in preserving this timber; if not you will have barren hills, small streams, and heavy floods.

Adjourned.

HELENA, MONT., August 9, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), Plumb, and Reagan; also Director Powell.

STATEMENT OF BENJAMIN H. GREENE, SURVEYOR-GENERAL OF MONTANA.

Mr. Chairman and gentlemen, I will read this report which I have in my hand. It is a report on irrigation made by the civil engineers of Montana. After I shall have read the report, Colonel De Lacey, who has a personal acquaintance with all the mountains and rivers of this Territory, will answer any questions you may wish to propound. The report is as follows:

HELENA, MONT., August 9, 1889.

DEAR SIR: By request of the Hon. T. H. Carter, Delegate-elect to Congress from this Territory, the Montana Society of Civil Engineers have prepared the following report on the present condition of irrigation in Montana, and a rough statement of what can be accomplished in that direction by the construction of suitable canals and storage reservoirs.

The Society have endeavored to obtain reliable data from the different sections of the Territory by distributing a large number of printed circulars with blank township plats, and from some sections have received replies which have proved of material assistance in compiling this report; other sections have failed to respond, and in these we have relied on a personal knowledge of the country furnished us by Colonel

W. W. De Lacy, one of the oldest and most experienced surveyors in this Territory, at present chief clerk of the surveyor-general's office at Helena.

Trusting that the data herewith furnished may be of material assistance to your committee in determining what is required in this Territory, the report is respectfully submitted.

Very respectfully,

B. H. GREENE,

President Montana Society of Civil Engineers.

Hon. WM. M. STEWART,

Chairman of United States Senate Committee on Irrigation and Arid Lands.

REPORT ON IRRIGATION IN MONTANA.

Montana is traversed by the main range of the Rocky Mountains, which crosses its northern boundary about 90 miles east of its northwest corner, and extends in a southeasterly direction to a point near the city of Butte; thence taking a westerly turn, it joins the Bitter Root Range and forms the southwesterly boundary between Montana and Idaho as far east as the National Park.

The western portion is consequently very mountainous, as there are many subsidiary ranges or spurs from the main range.

About two-thirds of the total area lying east of these mountain ranges consists of high table-lands, cut by large rivers which have their source in the mountains.

The principal rivers on this slope are the Missouri and Yellowstone.

The Missouri is formed by the Jefferson, Madison, and Gallatin Rivers, and flows northerly to the Great Falls, and thence easterly across the Territory.

Its principal branches are the Dearborn, Sun, Teton, and Milk Rivers, from the west and north, and the Smith, Judith, and Musselshell Rivers, from the south. The Yellowstone rises in Northwestern Wyoming, flowing northerly through the National Park to Livingston, and thence easterly and northeasterly, emptying into the Missouri near the eastern boundary of the Territory, at Fort Buford.

Its principal tributaries are from the south, and consist of Clark's Fork, Big Horn, Rosebud, Tongue, and Powder Rivers.

On the west slope of the mountains are the Deer Lodge, Blackfoot, and Bitter Root Rivers, flowing westward to the Columbia River.

The lands to be irrigated throughout the Territory may be divided into three classes, viz, valley, bench, and high table-lands.

The valley or bottom lands lie along the rivers, and have been mostly occupied by settlers, but are imperfectly irrigated and without any system, in dry seasons farmers having to fight for water.

The bench-lands are occupied in a few cases, and have been found very productive when irrigated.

The high table-lands are used entirely for grazing, and in many cases possess a rich soil.

The irrigation of these high lands is the most difficult problem to be encountered.

The large rivers in eastern Montana run in deep valleys from 200 to 500 feet below these high lands, which can only be reached by long and expensive canals.

It is not considered practicable to conduct the waters of the Missouri River to these table lands, but those of the Yellowstone River and its branches can undoubtedly be so utilized.

In western Montana there many available sites for reservoirs, the most notable of which are Red Rock Lake in Madison County, and a large lake-bed, nearly dry, lying north of Great Falls, in Cascade County.

The present season has been an unusually dry one, and fully two-thirds of the crops in the valleys of western Montana will be lost from the drought. Many large streams are entirely dry, there not being half enough water in them to supply the numerous small ditches.

On nearly all of these streams are suitable reservoir sites, and were dams now constructed these valleys would be abundantly supplied with water for the dry season.

Even in springs following mild winters a large amount of water is wasted by flowing to the lower rivers early in the spring before it is needed for irrigation, which, if held back in reservoirs, could be utilized for irrigating in the summer.

It is universally admitted that irrigation is required in all sections of Montana except in a limited area north of Flathead Lake, in Missoula County.

The irrigating season begins in May or June and ends in August, although hay lands are sometimes irrigated in the fall; that is to say, in October and November.

The snow-fall in the mountain ranges varies from 4 to 10 feet in ordinary winters, but last winter it did not exceed 2 or 3 feet, except perhaps in the Bitter Root Range.

In eastern Montana the usual fall is from 6 inches to 2 feet.

The canals and ditches at present constructed in the valleys are, with a few ex-

ceptions, small local affairs built by each farmer for his own private use. A few stock companies have built canals, the largest of which is in Gallatin County.

By the construction of larger canals and short distributing ditches, a considerable saving in the use of water might be effected.

It will be seen from the foregoing remarks that the works requiring the aid of the State or General Government in their construction consist of storage reservoirs in the mountainous portions, and large canals in northern and eastern Montana. With these works in operation it is probable individual effort would be sufficient to carry out the work of distribution.

Appended will be found a compiled statement of each county in the Territory, giving the principal ditches constructed so far as known, a rough estimate of the lands occupied by settlers and in part under cultivation, and an approximate estimate of the number of acres that could be brought under cultivation with suitable works for irrigation.

Summarized for the whole Territory these are as follows :

	Acres.
Total area of territory, 146,000 square miles, or.....	93,440,000
Amount of land now occupied and partially irrigated and cultivated.....	1,000,000
Estimated arid area that could be reclaimed.....	20,000,000

Of this amount it is not probable 3,000,000 acres will ever be reclaimed without the aid of the State or the General Government.

If these improvements were carried out, the lands would be raised from a valuation of \$1 per acre to \$10, or a total increase of over \$180,000,000.

The increase in live stock and personal property would amount to \$100,000,000 more. The agricultural population would be augmented by 500,000 people, and with the increased population of the cities, towns, and villages, engaged in commercial and manufacturing pursuits, the total population of Montana would be at least 1,500,000. All this can be brought about by an expenditure which, compared with the magnificent results to be accomplished, would be but a mere bagatelle.

The increased value of the lands now belonging to the United States would fully compensate them for the money expended in the works, and would furnish homes for over 1,000,000 of people, making the State of Montana one of the richest in the Union.

We have indicated on the map which accompanies this report the lands which can be irrigated wholly or in part, also the constructed ditches so far as known, and several proposed ones, which we believe to be practicable, but they require investigation by competent engineers; also several reservoir sites.

Beaverhead County.—Three thousand seven hundred and forty square miles; 48 townships surveyed; 34 townships sectionized; 680,000 acres.

It is not known how much ground is cultivated or inclosed for meadow land—estimated at from 70,000 to 80,000 acres.

It is supposed that with irrigation this might be increased to 250,000 acres.

This county is a very mountainous one, and the lands are generally high. It is watered by the Big Hole and Beaverhead Rivers, with their branches, the Grasshopper, Rattlesnake, Red Rock, etc.

There are narrow bottom and also bench lands on these streams. If the surplus water of the Beaverhead alone could be stored it would amount to a body of water 20 miles long, 12 miles wide, and 15 feet deep; one hundred billion cubic feet. The soil is alkaline on bottoms and sandy loam on table-lands. Irrigation is necessary during the growing season every two weeks, commencing in May and ending in August. Nothing can be produced without irrigation.

There are three canals on the Beaverhead, near Dillon, which will aggregate 62 feet in width and 4 feet in depth. These belong to organized canal companies.

There are a very large number of private irrigating ditches. The river has been dry for a number of miles this season. There are many excellent table-lands, which would produce largely if irrigated, and there are many natural sites for reservoirs. At Red Rock Lake a dam can be constructed which would back the water for 15 miles, and raise the lake 15 feet high. There would then be enough water stored for nine months that would reclaim thousands of acres.

Cascade County.—Two thousand five hundred and seventy square miles, 60 townships surveyed and 57 sectionized, or about 1,140,000 acres; of this there is supposed to be irrigated or under cultivation or fence about 50,000 acres. This could be increased probably, by reservoirs and canal, to 600,000 acres.

This county is watered by the Missouri River and its branches.

Sun River, Birdtail, St. Peters, and Dearborn in the west, and Arrow Creek on the east. On the east and south are the Highwood and Little Belt Mountains.

On the west the county is chiefly a table-land, from which arise isolated buttes, such as Birdtail Rock and Square Butte, near Fort Shaw.

There is a large town at the Great Falls, on the Missouri, with unrivaled manufacturing power in the water of these falls and the Big Springs.

There are several canals already partly built, in this county, of which there are the Sun River ditch, 9-foot base, 3 feet deep, 10 miles long, on Sun River.

Teton River canal, commencing at the mouth of Deep Creek, on the Teton, and extends to a point about 1 mile from the mouth of Muddy Creek, a confluent of Sun River.

This canal, with various reservoirs and canals, when completed, will irrigate the vast area of bench lands between Teton and Sun River. A branch canal is now in progress to connect the large lakes lying about 20 miles north of the Great Falls with the main canal, which will not only be a feeder, but will also render the lakes available for storage purposes.

There is also a ditch on the east side of the Missouri River, near the town of Chestnut. It is 8 feet wide, 3 feet deep, and about 10 miles long—and is intended to be continued for 10 miles more.

A reservoir can be established on Smith River, which runs for many miles through a cañon, and a canal taken out to water the bench lands between Smith River and the Missouri.

On the waters of Belt and Arrow Creeks also there are doubtless sites of reservoirs. *Choteau County.*—Twenty-four thousand eight hundred and thirty square miles; 145 townships surveyed; 140 townships sectionized, or 3,080,000 acres. It is supposed that about 50,000 acres are now cultivated, and that about 5,000,000 acres can be reclaimed by the use of canals and reservoirs. This county is very well watered by the main Missouri, which passes through it from south to east, having numerous branches, amongst which are, on the left bank, Sun River, Teton, Marias, and Milk Rivers, all with innumerable affluents. On the right bank are Sand Coulee, Box Elder, Belt Mountain, Highwood, Shonkin, and Flat Creeks, Arrow and Judith Rivers, and the Musselshell. The Blackfoot and the Fort Belknap Indian Reservation, and Fort Assiniboine Military Reservations are situated north of the Missouri and on Milk River. That part of this county between the Rocky Mountains, the Missouri River on the east and west and Sun River on the south and Marias River on the north, except the reservations, is a table-land of moderate elevation, unsuited to cultivation to an indefinite extent.

Several canals have been projected and are now being built. Of these, are the North Fork of Sun River Canal, 15 feet wide at base, 21 feet at top. The water is diverted from the North Fork of Sun River, and about 4 miles completed. It is intended to take it for many miles on the bench above Sun River. The North Fork offers an admirable site for an extensive reservoir.

Teton River Canal commences at the mouth of Deep Creek, a confluent of the Teton River, and extends across the table-land to Muddy Creek, a branch of Sun River, where it will be dammed, making a reservoir $1\frac{1}{4}$ miles long by three-fourths wide, whence there will be two canals taken out, one on each side of the stream. Other branches will be constructed to join the large lakes 20 miles north of Great Falls, from which canals will be made to irrigate the bench lands as far as possible.

There are other canals, such as the Rocky Gap Creek, or "Brown's ditch" Eldorado, 8 feet wide, $2\frac{1}{2}$ feet deep, 10 miles long, near the town of Choteau. Black Leaf ditch, 6 feet wide, 2 feet deep; Kipp ditch, and Lepley ditch, the precise situation of which is not exactly known. In the mountains, and on the banks of streams, there are everywhere excellent chances for making reservoirs and canals in this region of country.

On the right bank of the Missouri, in the region watered by the Belt Mountain, Highwood and Shonkin Creeks, there is no doubt, from the formation of the country, that the bench-lands can be reclaimed, and that reservoirs can be made in the Highwood Mountains in which these streams head.

There are small lakes to the east of Shonkin Creek, which no doubt could be used as storage reservoirs. Beyond this there are "bad lands," but to what extent is not known. North of the Missouri is a large scope of country extending to forty-ninth parallel, formerly comprised in the reservation of the Blackfeet and other tribes, but now thrown open to settlement, and watered by the Marias, Missouri, and Milk Rivers and their numerous affluents. This region contains an immense body of agricultural land, of which the larger and best part is on Milk River and its branches. The valley of this river is from 3 to 5 miles wide, with a deep rich soil. The river itself, in the spring, is full to its banks, but in the summer and fall it becomes very small. Most of the streams which flow into it on either side have water near their sources, but become dry or run in pools in the lower part of their course. On the bench-lands, just above the bottom lands of the river, the settlers have found a stratum of gravel containing water, and by sinking wells from 7 to 12 feet deep they can always obtain it. The table-lands have excellent soil generally, and if means can be found to get water on them will become very productive. Timber is scarce, but lignite coal is found in many places. But little is known of this country in an engineering point of view, and it is therefore impossible to state where reservoirs or canals can be built. The elevation of the country is supposed to be about 3,300 feet.

Crow Indian Reservation.—Seven thousand eight hundred and thirty square miles; 37 township exteriors surveyed; 18 townships sectionized. About 1,500,000 acres can be irrigated. Amount settled on is unknown. The Crow Reservation is watered by the Yellowstone River and its branches, the Stillwater, Rosebud, Rocky Fork, Clark's Fork, Pryor Creek, Big Horn, and Little Big Horn, with their affluents. Many of these streams have extensive bottoms.

The Big Horn River, below old Fort C. F. Smith, has one about 75 miles long and from 1 to 5 miles wide. The reservation is very well watered, and there would be no difficulty in making reservoirs and taking out canals anywhere.

The bench-lands between the creeks could be easily irrigated and would produce largely. There are many fine bottoms on the Yellowstone River.

Custer County.—Number of square miles 22,300, of which 550 are on Cheyenne Reservation; amount of surveyed land, about 131 townships, exteriors surveyed; 77 sectionized, amounting to 1,694,000 acres. Chief streams are the Yellowstone, and on its south side are Tongue and Powder Rivers, with their branches; Armell, Rosebud, O'Fallon, Cabin, Mizpah Creeks, with their branches, and the Little Missouri in the southwestern part. North of the Yellowstone are Pease, Alkali, Big and Little Porcupine, and Sunday Creeks. The majority of these run dry or in pools after the high water in the spring has ceased. Between these and the Musselshell is a table-land, which could probably be irrigated by a large canal or canals from the Yellowstone. The soil is good, and would produce largely if irrigated. On this table-land are many depressions which could be used as storage reservoirs; the fall of the Yellowstone is sufficient for this to be done. On the south all the large streams contain water. There are already many small ditches for irrigating purposes, and two large ones are on the north side of the Yellowstone, at Pease Bottom, and another near Miles City. It is supposed that about 30,000 acres are under irrigation. By means of large lateral ditches and storage reservoirs in basins on the table-land this amount can be very largely increased, say to about 3,000,000 acres.

Dawson County contains 25,650 square miles, of which 3,080 square miles are contained in the Fort Peck Agency Reservation, and 375 in the Fort Buford Military Reservation.

There are 73 townships, the exteriors of which have been surveyed, of which 47 have been subdivided.

The county is thinly inhabited along the Yellowstone and its branches in the southeast and the Musselshell Valley on the west, and Milk River and the Missouri on the north.

That part lying between the Yellowstone, Missouri, and Musselshell is a table-land, generally destitute of water. There is a large water-course, called Big Dry Creek, but it has very little water in it, except pools, in the summer time.

A canal, however, from the Yellowstone or Musselshell might reach it, and the soil could be readily made very productive. A canal taken from the Yellowstone and running back of it some 20 miles would also open a large scope of good country, and there is also good land on the Missouri which could be opened in the same way.

Whilst there are 15,000,000 acres in the county, there would be probably not more than 4,000,000 which could be reclaimed as above mentioned. There have been a few ditches made in the Yellowstone country on the north side, such as the Clear Creek ditch, 6 feet wide, 2½ feet deep, 4 miles long—has a reservoir containing 45 acres. Creek is 40 miles long, with drainage 10 miles in width. Water can be increased by digging down to bed-rock and putting in dam.

About 12 miles from Yellowstone, on Fox Creek, is natural reservoir or lake, about 4 miles long, 1 mile wide. About one-eighth is covered with water in dry season. If a dam were constructed across the lower end of the lake, where it is a quarter of a mile wide, the water could be taken from the bed of Fox Creek by ditches. This project would make a reservoir about 3,000 acres in extent, and would redeem many thousand acres.

There are also ditches taken out of Spring Creek, Crane Creek, and Fox Creek, and most of the farmers have ditches.

Water can be taken out of the Yellowstone about 35 miles above Glendive and ditch probably could be continued to the mouth of the river, 120 miles, which would reclaim all the valley lands on the Yellowstone in Dawson County. A number of streams could be turned into the ditch.

Deer Lodge County.—Four thousand seven hundred and sixty square miles; 31 townships surveyed and sectionized, or 620,000 acres.

It is supposed that about 100,000 acres are under cultivation or inclosed, and that 350,000 acres can be reclaimed by irrigation by means of reservoirs and canals.

This county is a very mountainous one, and is situated on the headwaters of the Columbia River. These mountains have a large amount of pine timber on them. It is remarkably well watered by the Deer Lodge, Little Blackfoot, and Big Blackfoot Rivers, and Nevada, Flint, and Stony Creeks and their branches.

The principal valley is on the Deer Lodge River, which has a course from south to

north, where the county seat, Deer Lodge City, is situated, and also the large mining town of Anaconda. This valley is about 30 miles long and 12 miles broad, and has an elevation of about 4,500 feet. There are a number of branches to this stream on both sides, of which Warm Springs Creek is the longest. The branches on the west side are more numerous and contain more water than those on the east side of the river. There are also small lakes which could be used as storage reservoirs. If this were done and the water distributed by canals, many thousands of acres now idle could be utilized. The Hellgate River, below the junction of the Deer Lodge and Little Blackfoot Rivers, runs through a narrow gorge or cañon, but there are small valleys and settlements here and there along it. There are also valleys and settlements on the Little Blackfoot, Big Blackfoot, Nevada Creek, Flint Creek, and many other places.

Owing to the mountainous and timbered character of the county, and the abundance of water, there should be no difficulty in making large irrigating canals or finding sites for reservoirs. There are many private ditches but no large canals in this county.

From information received, on the Upper Flint Creek about 3,000 acres could be reclaimed by reservoirs. There are very fine locations for such on Flint Creek just below the falls, and also on Trout Creek, one of its tributaries. The sites would be sufficiently elevated to cover a large section of land on the dividing bench between them.

At the mouth of Flint Creek, near the town of New Chicago, on Willow Creek, one of the affluents to the left bank, a reservoir there established would reclaim between 10,000 and 12,000 acres.

The snow in the mountains falls very deep, ranging from 6 to 10 feet, and consequently in the spring the streams rise very high.

There is no doubt that irrigating canals can be established, and large quantities of land reclaimed, but the cost is too great for local efforts. Nearly all the grains and most of the vegetables are grown in this county that can be raised in other parts of Montana.

Fergus County.—This county contains 7,415 square miles, or nearly five million acres. It is bounded on the west and southwest by the Little Belt Mountains. In the south and center are the Big Snowy Mountains, separated from the Little Belt Mountains by the Judith Gap, a very remarkable pass, 3 miles wide.

The Big Snowy Mountains turn north and are succeeded by the Little Judith Mountains, which again join on to the Judith Mountains north of them. These different ranges form a semicircular "belt" (whence the name) inclosing the Judith Basin, watered by the Judith River and Arrow Creek and their affluents.

This basin contains a great deal of excellent land, both table and bottom, along the creeks. It is also well cultivated, and contains many sheep ranches and bands of cattle. The elevation of the valley is about 4,000 feet.

South and east of the Big Snowy Mountains are the tributaries of the Musselshell River, of which the Swimming Woman, Flatwillow, and Box Elder are the largest and most permanent. There are extensive bottoms and also table-lands of moderate height on the Musselshell, which can be irrigated by canals and would produce well. There are also many opportunities of forming reservoirs in these table-lands, as in many places there are small lakes which could be enlarged and transformed into reservoirs.

The Judith River, heading as it does in the mountains, affords excellent opportunities for making reservoirs and taking out canals for irrigating the numerous table-lands and bottoms with good effect.

On the east side of the Judith River, near the town of Lewiston, is a remarkable spring, called the Big Spring, once undoubtedly a hot spring, as its waters are still of such a temperature that neither it nor the stream flowing from it ever freezes in winter. This would yield a large body of water for irrigating the surrounding benches. There are no large canals in this county, but a very large number of small ditches.

Many of these mountain streams totally disappear for miles after reaching the plains, and afterwards reappear. There is no doubt that careful examination would develop many sites for canals and reservoirs. There are at present more than 150,000 acres under cultivation, and with canals and reservoirs probably 1,500,000 could be reclaimed.

One hundred and sixty-four townships, with exteriors, surveyed; 117 townships sectionized, amounting to 2,696,000 acres.

There are fine sites for reservoirs on the heads of Wolf Creek, which is also one of the finest parts of the county for agriculture.

Gallatin County.—Two thousand nine hundred square miles; 28 townships exterior run; 19 townships sectionized, or about 360,000 acres.

There are probably 100,000 under cultivation. And 400,000 could be reclaimed by irrigating works, such as reservoirs and canals.

This county is watered by the East and West Gallatin Rivers, Middle Creek, and

their branches. Also in the western corner are part of the Madison and Jefferson Rivers. The Gallatin Valley is very valuable and highly cultivated agricultural ground. There is also some arable land on the Jefferson and Madison.

There are a great number of small ditches taken out of the different streams for private irrigation. One large canal has been built extending along the base of the mountains from the West Gallatin to the East Gallatin River. This canal is 25 miles long, is 24 feet wide on bottom, and 4 feet deep. It narrows on approaching the East Gallatin to 14 feet wide and 3 feet deep, will carry 8,000 inches of water, and has cost \$100,000.

There is also the Middle Creek ditch, carrying 2,000 inches of water.

Other canals could no doubt be taken from the West Gallatin and Madison, and reservoirs established, as the country surrounding the Gallatin Valley is hilly and mountainous. As the valley is high, considerable snow falls in the winter, and the streams can consequently rise very high in the spring, the surplus water of which could be stored.

Jefferson County.—Two thousand and sixty square miles; 40 townships exteriorly surveyed; 33 townships sectionized, supposed equal to 660,000 acres.

Estimated that 250,000 can be irrigated. There may be 25,000 acres cultivated or inclosed.

This county is bounded on the east by the Missouri and on the South by the Jefferson Rivers, and is watered by their affluents, the Prickly Pear, McClellan, Beaver, Crow, and Hot Spring Creeks, on the north and east, and Bowlder River, White Tail Deer, and Pipestone on the south. The valleys are generally narrow. A canal could probably be taken out of the Jefferson River, on left bank, which would irrigate a large amount of land adjoining it and the Missouri.

There are reservoir sites in the mountains in several places, particularly in the Crow Creek Cañon and head of Beaver Creek. There are two ditches on Crow Creek of a capacity of 1,870 and 1,000 miners' inches, respectively.

The irrigating season begins in May and ends in August. In the Crow Creek Valley alone it is estimated that two or three times the amount of ground could be cultivated beyond what is now in use, if irrigated by means of reservoirs.

The snow falls from 5 to 6 feet deep in the mountains in usual winters. No crops can be raised without irrigation. The crops on 4,000 acres have been lost this year in consequence of want of water.

Lewis and Clarke.—One thousand seven hundred and sixty-nine square miles, of which 1,142 square miles is mountainous land, valuable for timber and grazing. There are about 400,000 acres which, if irrigated, would be susceptible of cultivation.

Thirty-six townships surveyed, of which 33 have been sectionized, or 660,000 acres. It is supposed that there are about 50,000 acres inclosed or under cultivation.

The county is bounded on the east by the Missouri and Cascade County, on the north by Sun River, on the west by the Rocky Mountains, and on the South by a spur of the Rocky Mountains and a line extending east to the Missouri River. The principal streams are the Big Prickly Pear and its branches, Ten and Seven Mile Creeks; Silver Creek, Little Prickly Pear, the Dearborn and its branches, and Sun River and its branches, all of these streams being affluents of the Missouri.

The Big Prickly Pear Creek with its affluents, Ten Mile, Seven Mile, etc., waters a large valley, well cultivated, containing the city of Helena, and surrounded by mines and mining districts. There are probably about 6,000 acres irrigated and under cultivation.

The entire basin could be irrigated by a good reservoir system and by new ditches.

There are available sites for reservoirs at the junction of Prickly Pear and McClellan Creeks, where two reservoirs can be constructed; aggregate capacity, 38,000,000 cubic feet. A series of reservoirs can be built in McClellan Gulch.

Ten Mile Creek at its headwaters affords fine facilities for reservoir sites, as do also the headwaters of Seven Mile and Silver Creeks.

The water-flow in high water of different streams is estimated as follows:

	Miners inches.
Junction Prickly Pear and McClellan Creeks.....	30, 000
Ten Mile Creek	20, 000
Seven Mile Creek	8, 000
Silver Creek	8, 000
Total	66, 000

or about 102,960 cubic feet per minute, which is sufficient to fill a reservoir 1 mile square 5.32 feet in 24 hours.

There are a number of private ditches taken out of Ten Mile and Prickly Pear, sufficient to use all the water contained in them in the irrigating season.

The principal ditches are the Helena ditch, capacity 1,000 miners' inches; and another, capacity 2,000 inches. These are mining ditches taken out of Ten Mile.

There are also ditches from Seven Mile and Silver Creeks which now take up all the natural flow of these creeks.

From these sources of supply only 6 per cent. of the Prickly Pear Basin can be irrigated.

The greater part of the remaining 300,000 acres is in the valley of Sun River and on the Dearborn and Flat Creeks. Only about 4 or 5 per cent. is now under cultivation.

There are now canals being constructed in these parts of the county.

One of these, the Dearborn and Flat Creek canal, is $4\frac{1}{2}$ miles long, 20 feet wide on bottom, 4 feet deep, and has a dam in Dearborn River 12 feet high, 21 feet wide, 200 feet long.

The other, the Florence canal, is taken out of the South Fork of Sun River, near the town of Augusta. It is 12 feet wide at base, 18 feet on top. It is to be $2\frac{3}{4}$ miles long, of which 8 are already built.

There is a fine basin on the headwaters of the Little Prickly Pear. Owing to its formation heading in a cañon, a reservoir can be easily established, which will irrigate the whole of this valley. There are facilities also for this purpose on the headwaters of the Dearborn and of Sun River, and thence by canals the bench-lands can be easily irrigated.

Madison County.—Four thousand five hundred and forty-six square miles; 80 townships surveyed; 46 subdivided, or 920,000 acres, of which about 500,000 acres could be irrigated by reservoirs and canals.

It is estimated that there are about 100,000 acres now under cultivation.

This county is well watered by the Madison, Jefferson, and Ruby Rivers and their branches; also in the west, for a short distance, by the Big Hole or Wisdom River, and head of the Black Tail Deer Creek. All these streams have arable land, both bottom and table lands. There are a number of streams flowing from the mountains, many of which head in small lakes, which offer excellent opportunities for the making of reservoirs and canals. This is especially the case on the Ruby and the Madison Rivers. There are no large canals built, but a very large number of private ditches.

The snow falls very heavily in the mountains, sometimes as deep as 8 feet.

The irrigating season lasts from about 15th June to 1st August. Meadows can be irrigated at any time.

Nothing can be done without water.

Several very fine sites can be found for reservoirs at the head of Ruby River, and also at Red Rock Lake at the head of a branch of Red Rock Creek, and on the Madison River.

Meagher County.—Seven thousand one hundred and sixty square miles in county; 94 townships surveyed; 90 townships sectionized.

It is supposed about 500,000 acres can be irrigated.

About 35,000 acres is supposed to be cultivated.

The county is very mountainous.

It is watered by the Missouri River and by its branches, flowing into it on the east side; also by Smith River and the Musselshell.

There is excellent bottom and bench land on the Missouri River. These are now irrigated by small, private ditches. There could be reservoirs established on some of the streams, and canals taken out, notably on Sixteen Mile Creek, which would enable a large amount of land to be farmed, now useless. The valley of Smith River is about 5,000 feet high, and is better fitted for grass than for agriculture, although both wheat and oats will grow there. There are good sites for reservoirs at various points.

On the Musselshell, also below the forks, there is plenty of bench, land to be reclaimed, and sites for canals and reservoirs on Big Elk, Lebo, American Fork, and Fish Creek, and along the Musselshell River.

Missoula County.—Nineteen thousand five hundred and eighty square miles; 22 townships surveyed and sectionized, or about 440,000 acres; there are, perhaps, about 150,000 acres inclosed or under cultivation.

This county is watered by different branches of the Columbia River, being the Hellgate and Bitter Root Rivers, which unite and form the Missoula River, which again unites with the Flathead River to form the Clark's Fork of the Columbia. Part of the Kootenai River, coming south from the British possessions, waters the northwest corner of the county.

The Flathead Indian Reservation, containing about 2,100 square miles, is in this county, extending from Clark's Fork of Columbia to the middle of Flathead Lake.

The west and longest valley is that of the Bitter Root, on the river of that name. It is about 55 miles long and about 12 miles wide, with an average height of 3,300 feet. The valley is on both sides of the river, which has numerous affluents. Its general course is due north. This valley is very fertile, and has a mild climate in winter. It is remarkable as being the earliest settlement in Montana.

The Jesuits had a mission amongst the Flatheads, where Fort Owen now is, in 1842,

and made a farm and raised wheat and vegetables about that time, or shortly after. They sold out to Major Owen in 1852, who erected a trading post, still in existence, and it became a rendezvous in the winter for the men who traded with the emigrants on the California routes. Here they brought their bands of horses and cattle. These men gradually settled down and went to farming, and when Captain Mullan came through here in 1859 there was quite a little settlement.

The west side of this valley is remarkably well supplied with water from numerous streams, and there are a number of private ditches, and the greater part of the available ground is reported as being irrigated and reclaimed. Much of the ground is timbered. There are orchards on this side, planted by Bass Brothers, N. B. Harlan, and perhaps by others.

Up to the 1st of August the creeks furnish all the water needed. This year, being the driest ever known, there has not been enough.

The east side of the Bitter Root Valley is not so well watered, there being only three large creeks—Burnt Forks, Skalkaho, Weeping Child—and a few small ones.

There is a large amount of good farming land, and several ditches are taken out of the main river, of which one, the McCarthy ditch, commencing 8 inches about town of Stevensville, 10 feet wide, supplies several farms.

Shepherd ditch, size not known.

Harlan ditch, 12 feet wide, 5 miles long, carries 2,000 inches water; supplies water to 1,000 acres of land; cost \$6,000.

Humble ditch, near Corvallis, size unknown.

Surprise ditch commences 6 miles above Corvallis; 12 feet wide, 6 miles long, 2,000 inches water; cost \$10,000. Incorporated company.

Republican ditch taps river near mouth of Weeping Child Creek; 12 feet wide, 11 miles long.

W. B. Harlan takes water from Rock Creek on west side, and brings it across the river to his ranch in a flume suspended by a wire cable. He has a large orchard of 1,500 trees, apple, plum, cherry, and pear, several hundred of which are in bearing. It is estimated that on the east side of the Bitter Root at least 50,000 acres additional could be reclaimed by canals and reservoirs. The head of the river and many of the streams on both sides run through cañons, where reservoirs could be easily constructed.

The irrigating season commences in June and ends about 1st of August. When snow fall is light, it is necessary to irrigate in April before plowing. Meadows are irrigated early in the season and late also. Fruit trees should be irrigated on the approach of winter. Nothing can be done without irrigation, except in the river bottoms, which get either the overflow or seepage from the river.

There has been produced in this valley by irrigation, wheat, 20 to 60 bushels; oats, 30 to 110; peas, 20 to over 80; corn, as high as 50; potatoes, from 130 to 600 bushels, of these, some weigh from 4 to 4½ pounds. Tomatoes, melons, and squashes are all grown here. Apple and plum trees grow more fruit than they can hold up.

All northern small fruits grow in great profusion. This valley may be said to be the garden spot of the mountains.

There are other valleys on the Hellgate and Missoula Rivers, called Hellgate Ronde, Grass Valley, and Frenchtown Valley, extending along these rivers at intervals for 24 miles.

In this section are reported 3 ditches taken from Grant Creek in the Hellgate Ronde, carrying, respectively, 200, 600, and 1,000 inches. These take all the water of the creek.

These valleys, with irrigation, produce all the different varieties of grain, trees, and vegetables. Mr. Flynn reports that he raised 5,600 bushels of oats on 100 acres last year. Nothing can be done without irrigation. All of these valleys could probably be irrigated from the Big Blackfoot or Missoula River, which contain plenty of water, sufficient for large canals, and there are quite a number of creeks which could be employed as feeders.

There are small valleys, also, in Clark's Fork, of which the largest are those called the Horse Plains and Thompson's Prairie, which are now settled upon along the Northern Pacific Railroad. There is not a large amount of agricultural land along this stream, most of which is heavily timbered. There would be no difficulty in irrigating what there is from the river, which is very large and has a heavy fall.

There is also a very fine agricultural district on the Flathead River, above the large lake of that name. The altitude is about 2,500 feet, and it is reported that every kind of grain and vegetable can be grown there without irrigation. This is accounted for by there being more moisture during the spring and summer than in other sections of the country, which may be accounted for probably by the vicinity of the lake and the heavy timber.

On the Indian reservation, which contains a large amount of fine land, agriculture has been practiced for more than 30 years by the Jesuit fathers and the Indians under their direction. Very fine crops have been raised. There are also large bands of horses and cattle.

Irrigation, when practiced in the Bitter Root Valley and elsewhere, requires about 1 inch per acre. The water is allowed to run 2 or 3 days at a time, and generally 2 or 3 times in the season.

The snow falls from 10 to 4 feet deep in the mountains, and all the streams rise very high in the spring. With storage reservoirs an immense amount of water could be saved for irrigation.

Park County.—Four thousand seven hundred and forty square miles; 55.5 township exteriors surveyed; 40 townships sectionized. About 500,000 acres could be irrigated by canals and reservoirs. Supposed about 15,000 acres now under cultivation. This county is very mountainous. The Crazy Mountains are situated in the north, on east side of Shields River. On the west it is bounded by the Gallatin Range and the Bridger Mountains, and in the south are the Snow Mountains and the Bear Tooth Range, with their numerous spurs.

There is a valley on both sides of the Upper Yellowstone which can be irrigated by the Yellowstone or its branches: also on Shields River, which is quite a long stream with many affluents, giving an excellent opportunity for canals and reservoirs. East of the Crazy Mountains and north of the Yellowstone there are many streams, such as Duck, Gage, Little Timber, Big Timber, Medicine Bow, Sweet Grass, and White Beaver Creeks.

These generally cut through a table-land, which has good soil and is nearly level. A canal from the Yellowstone, taken out near Livingston, would soon reach this bench and bring into cultivation a very large area. There are opportunities, also, of making reservoirs on it as noticed in report of Yellowstone County.

The southern part of this county, adjoining the Crow Reservation, is generally very mountainous and broken, but there are many settlers at Rocky Fork and Red Lodge, where the coal mines are situated. There is plenty of water, but the agricultural land is circumscribed.

Silver Bow County.—Seven hundred and sixty square miles; 8 townships surveyed; 7 townships sectionized. It is supposed that about 40,000 acres could be irrigated and rendered productive. The amount under cultivation is unknown—certainly not 5 per cent. This county is essentially a mining county, containing, as it does, the great mining town of Butte. The average height must be about 5,000 feet, and the agricultural portions are situated along the Big Hole or Wisdom River, in small bottoms; on Divide Creek, one of its branches, and in the Silver Bow Basin, at the head of Silver Bow Creek, around the town of Butte.

There are many mining ditches in the Silver Bow Basin and along that stream, which is a branch of the Deer Lodge River. One or two of these ditches cross the divide at the Deer Lodge Pass, which is 3 miles wide, and thus unite the waters of the Missouri and Columbia Rivers. A canal could be taken out of Wisdom River which could irrigate most of the agricultural land on the south side of the Rocky Mountains in this county, and reservoirs in the mountains, sites for which can be readily found, with canals, could irrigate the lands on the north side.

Yellowstone County.—Three thousand three hundred and ninety square miles, or 2,272,000 acres; 62 township exteriors surveyed, of which 49 are sectionized. About 500,000 acres can be irrigated, mostly by canals from Yellowstone and Musselshell.

Between these two rivers there is a bench-land; this is about 170 and 200 feet above the Yellowstone, but can be reached by a canal from either the Musselshell or Yellowstone. Midway between the two rivers is a depression, which has been the bed of a lake, and can be readily turned into a reservoir. The streams flowing into both the Musselshell and the Yellowstone are generally small.

There are two ditches or canals on the Yellowstone, north side—one 20 feet wide and about 27 miles long, and the other 10 feet wide and about 15 miles long, inside or south of the other one.

There are probably about 50,000 acres irrigated.

RECAPITULATION.

No.	County.	Area.	Supposed under cultivation.	Supposed can be cultivated by irrigation.
		<i>Sq. miles.</i>	<i>Acres.</i>	<i>Acres.</i>
1	Beaverhead.....	3,740	80,000	250,000
2	Cascade.....	2,570	50,000	600,000
3	Choteau.....	24,830	50,000	5,000,000
4	Crow Reservation.....	7,830	.....	1,500,000
5	Custer.....	22,300	30,000	3,000,000
6	Dawson.....	25,650	50,000	4,000,000
7	Deer Lodge.....	4,760	100,000	350,000
8	Fergus.....	7,415	100,000	1,500,000
9	Gallatin.....	2,900	100,000	400,000
10	Jefferson.....	2,060	25,000	250,000
11	Lewis and Clarke.....	1,700	50,000	400,000
12	Madison.....	4,546	100,000	400,000
13	Meagher.....	7,160	25,000	500,000
14	Missoula.....	19,580	150,000	600,000
15	Park.....	4,740	15,000	500,000
16	Silver Bow.....	760	1,000	40,000
17	Yellowstone.....	8,390	50,000	500,000
	Total.....	146,000	986,000	19,790,000

The CHAIRMAN. How long have you resided in Montana?

Mr. GREENE. Nearly four years.

The CHAIRMAN. Have you traveled considerably over the Territory?

Mr. GREENE. Not a great deal.

The CHAIRMAN. Suppose the United States Government should make the necessary surveys so as to determine the cost of construction of reservoirs, etc., would not that, in your opinion, be of service to the people of Montana, and could not a large area of country be easily irrigated that is not now in use.

Mr. GREENE. I am prepared to answer "yes" to that. I have seen enough for that.

The CHAIRMAN. Would you not before the surveys could be completed have a large increase in your population, taking up all the convenient places first? Do you not think it a little premature to say how vast sums of money shall be expended before you have the lands taken up?

Mr. GREENE. Yes.

The CHAIRMAN. Mr. Plumb, the chairman of the Committee on Public Lands of the Senate, is here, and I would like you to state, if you have reflected on the subject, what changes would be necessary, if any, in the present land laws to enable people to occupy these lands and at the same time prevent the water falling into the hands of the few, and thus have the water and land divorced.

Mr. GREENE. The great difficulty we now labor under and have since my residence here, is that the land surveys are inadequate. We can not locate a great deal of this property by land lines. There is not a survey for all the eastern portion of Montana, and my office is filled with applications from settlers.

The CHAIRMAN. Are the homestead laws inadequate to enable settlers to acquire title where irrigation is necessary? Do they need modification?

Mr. GREENE. I fancy they would meet the case. I think they would meet the exigency.

The CHAIRMAN. As surveyor-general for this Territory I would ask you whether you have observed or not the denuding of timber from the

land, burning it off, as it has been for two or three years. What effect has that had upon the streams and the moisture? Have you observed?

Mr. GREENE. No; you see I am so closely confined to my office that I do not have the opportunity of observing. I presume it is the same as in other countries—the moisture evaporates much more rapidly.

The CHAIRMAN. Suppose instead of secret agents, such as we now have, we had timber agents appointed to let the people have the timber at reasonable rates, on condition that they would take care of the underbrush and dead timber and assist in preventing fires, do you think you would have the co-operation of the community in carrying it out?

Mr. GREENE. I feel very sure we would. It is preferable to the present system, if you can call it a system.

Senator PLUMB. What Senator Stewart is aiming at is this: Is a system which is not designed to proceed upon a theory that every one who takes public timber may be prosecuted for it, and so on, but a system which shall permit every one who wishes to have such timber as he needs, sparing the small growth, or to take the timber under terms which are consistent with his integrity and self-respect, and at the same time not burdensome in a financial way—a system which simply permits the taking of the larger timber as it is needed and which will protect the remainder from fires, leaving the underbrush on the ranges to catch the snow. He wishes your view as to the merits of two systems. And I would like to have your views myself, because it is a question to which I have given attention here and elsewhere. We want a system that will meet the views of the Government and the people of this country.

Mr. GREENE. It would be suitable to the people.

Senator PLUMB. As it is now, any one who cuts timber is liable to be brought before a magistrate, there to show whether he cut the timber for certain specific purposes or not.

Mr. GREENE. Yes.

Senator PLUMB. That is to say, a man who cuts timber for a mining company or a mill is liable to be arrested for the purpose of ascertaining whether he is cutting within the purview of the act of Congress. The system which Senator Stewart suggests would enable the people to have all the timber they might want for use in the Territory, upon a legitimate basis of minor compensation, at the same time keeping all that is valuable to the Government in the shape of underbrush, which will replace what is taken away and hold the snows and prevent their evaporation after they fall. That is the question between these two plans. Which would be the better?

Mr. GREENE. I can only say that I fancy such a system would be acceptable. There are others here who could speak very positively on that subject. Colonel Sanders could give you an expression of public opinion on that subject.

The CHAIRMAN. I would like to hear from mining men, or their representatives, as to what system the community here would assist in carrying out, so that the mountains would not be denuded, and thus permit the water in flood times to rush down and injure the country. No system can be carried out unless the people help to do it.

Senator PLUMB. Do you know about the Yellowstone Valley? Have you ever been there?

Mr. GREENE. I never have.

Senator PLUMB. You do not know anything about whether the boundaries of that Park are what they should be with a view to preserving the natural curiosities, the water supply, game, fish, etc.?

Mr. GREENE. No; I have never been at the Park.

STATEMENT OF W. F. SANDERS, OF HELENA.

The CHAIRMAN. How long have you resided in Montana?

Mr. SANDERS. Twenty-six years, lacking a few days.

The CHAIRMAN. What has been your occupation?

Mr. SANDERS. I have been mining, farming, practicing law, and perhaps some other occupations that have escaped my memory.

The CHAIRMAN. Are you acquainted with the whole Territory?

Mr. SANDERS. Yes; except that portion which is occupied by Indians, and that I have been over as much as most other persons.

The CHAIRMAN. Has your attention been called to the question of preserving the timber that is used for holding the snows and saving the moisture, and at the same time allowing people to cut timber?

Mr. SANDERS. Yes; I have looked over the difficulties of the situation considerably.

The CHAIRMAN. What system would you suggest as best calculated to preserve the timber and enable the people to have what they need, and at the same time secure their co-operation in carrying out the wishes of the Government?

Mr. SANDERS. First, as to the co-operation of the people. That is assured. They have an interest in it personally, while the Government's interest is public. We have laws upon the statute-books denouncing very severe penalties upon anybody who puts this timber in peril by leaving fires out—setting out fires in any shape to burn up the timber, which is the great cause of its destruction in the Territory. There has been more timber burned in Montana in the last month than has been used by the people for twenty-five years, I think. And what has occurred in the last month occurs almost every year. It takes the entire summer season to destroy as much timber as was destroyed during the month of July.

Fires result very frequently from lightning. That has occurred under my observation. More, however, are from the Indians leaving out fires and setting out fires; some white persons do that too. To punish these persons, many years ago a law was passed, I do not remember the penalty, and we have printed that law upon cloth and posted it upon the trees along the highways of Montana. I mention this fact to show that the people of Montana have a profounder interest in this question than anybody else has.

The CHAIRMAN. Does the timber in this Territory usually grow upon agricultural land?

Mr. SANDERS. There is practically no timber upon the agricultural lands of Montana. A few poplars of one kind and another, and willows along the banks of the streams, are all the trees that are on agricultural land, and cottonwood, which is a kind of poplar. So that, speaking practically, there is not a stick of timber that can be obtained by a citizen of Montana, except under the law allowing the cutting of timber on mineral land. Whether the destruction of timber by the people for their own use over this area is greater than the reproduction of it by nature I can not answer. I think that is in doubt. There are, however, three kinds of trees growing here to which we might direct your attention. There is what we call the lodge-pole pine; the scientific name I do not know. It grows densely and like wheat in a field, from 30 to 70 feet high, and is from 6 to 10 inches in diameter. There is pine proper, and there is also a kind of fir. These three practically furnish all the timber that is in Montana. The Rocky Mountains are an up-

heaved rock, covered with a very thin layer of drift, on which these trees grow. They demand moisture and fertility to supply them, and when they get so dense, so large, that the supply is not adequate, they die, fall down, become dry and feed the flames that destroy the timber that is healthy. Those fires do more to destroy the timber than the people do.

From this point west, traveling through the forests of pine and fir and cedar, an observing person will find that a great many trees have fallen and are lying upon the ground. If that person will examine them, he will find that they are decayed inside. And then you go and chop down trees for saw-logs or any purpose for which they are needed, and you will frequently find them in the same condition—decayed inside.

The CHAIRMAN. Would cutting out the other trees and cleaning off the dead ones make the fires less liable to occur?

Mr. SANDERS. Unquestionably. Nature has not revealed any more to me than she has to anybody else; but it is perfectly apparent that those trees decay because they lack some nutrition. That you will find in trees of various sizes.

The CHAIRMAN. Do the trees grow very closely together?

Mr. SANDERS. Yes, they grow closely together. I am speaking of the larger trees. It is a dense forest.

The CHAIRMAN. Then they drop down and become dry wood? Do they rot rapidly?

Mr. SANDERS. They remain there a long time. The country is very dry, and the trees full of resinous substance, and they feed the flames easily.

The CHAIRMAN. Suppose the Government, instead of having secret agents, should have timber agents with convenient districts under their control to regulate the cutting of timber, to carry out instructions and allow the people to have what timber they want at a nominal price, reserving the land—to have no land for sale—and imposing upon the people the condition that they should remove the dead trees and preserve the underbrush—these timber agents to be men who live in the different communities and known to the people, could there be more done than is now done to preserve the forests?

Mr. SANDERS. I have reflected upon this question in all its aspects. In the first place, I believe that everybody who goes upon the public domain and cuts a tree should be held responsible under penalties to take care of the limbs and see that they are destroyed, so that they may not feed the fires.

The CHAIRMAN. What would you think about a condition, where they are cutting timber for mining purposes, to compel them to remove the dead timber?

Mr. SANDERS. I am opposed to the Government turning itself into a huckster-shop by selling the timber. I think the people should be free to go there, provided they obeyed certain regulations which should be made. I think the people of Montana would exercise sufficient espionage over citizens who went there, and that it would not be unjust to them if the Government had individuals there to see that the regulations were enforced.

The CHAIRMAN. Would you have a certain officer there to look after the district or an agent sent out? What would be the best scheme?

Mr. SANDERS. It might be that you could not get anybody here to take the place; so that you would do better to import them.

The CHAIRMAN. Would such a place be unpopular out here?

Mr. SANDERS. Not at all.

Senator PLUMB. The question the Senator desires to put is this: You have a system which permits you to take timber for certain purposes, and if the question arise whether or not it is taken for this purpose the man who takes the timber is liable to prosecution by some agent who may take the view that he should be prosecuted, and, therefore, whoever cuts timber is running a certain risk; because the Government maintains agents here who are bound to do something to earn their salaries, and frequently they recommend prosecutions that can not be maintained. Suppose we substitute for that system one that will permit everybody to have the timber, who may want it for his own use, at a price which will repay the cost of administering the system, and limit the cutting of timber to the amount that the person may need—make the whole thing legitimate—do you think that would be preferable to the system which is now in operation? Do you think the latter would be more acceptable to the people than to have the present one with the risk they are running?

Mr. SANDERS. A thousand fold.

The CHAIRMAN. You are in favor of a system whereby the Government shall regulate the cutting of timber, so that a sufficient amount of undergrowth can be preserved to keep up the forests, and you would not recommend the selling of any timber land where agriculture can be pursued, but would keep it as it is?

Mr. SANDERS. No; I do not wish to legislate against rich men; but I do not know any way of preventing rich men cutting any more timber than the poor man. There is another regulation that has been enforced with strictness and almost cruelty. I do not see why the timber in Idaho should not be brought into Montana.

The CHAIRMAN. You would allow a free cutting of the timber under such regulations as would allow the forest to grow up again and to take it anywhere in the United States?

Mr. SANDERS. Yes; that is what prosecutions have rested upon, and it has done more to demoralize and wreck public justice than anything else. It is not good to enforce a law that is against the sense of justice. While in these prosecutions they have been able to prove that this timber was cut, they have been unable to prove that it was on mineral land, and the juries will find according to the proof. They do not believe in the system, and it seems to us petty for a Government with 60,000,000 of people to go around huckstering its wood.

The CHAIRMAN. In regard to irrigation—you have traveled over this Territory and are familiar with its topography.

Mr. SANDERS. Yes.

The CHAIRMAN. Would the settlement of the country be materially advanced if we had surveys showing where reservoirs could be made and where the ditch lines would be, with estimates of the cost of constructing them, so that the people could understand the situation?

Mr. SANDERS. Very much.

The CHAIRMAN. Could the population be largely increased before the inauguration of the great enterprise of utilizing the waters of such rivers as the Yellowstone and Missouri? Could much be done by the people themselves?

Mr. SANDERS. Yes; considerable could be done by the people.

The CHAIRMAN. Then we may postpone the discussion of who shall do the great work until we can see what we have to utilize—until we shall have ascertained what the people themselves can utilize.

Mr. SANDERS. In the light of economy I think these reservoirs should be one above another in lateral streams. It is easy to take the water

around to a lateral stream where there is a good place for a reservoir.

The CHAIRMAN. And in lateral valleys?

Mr. SANDERS. Yes.

The CHAIRMAN. That is a question for an engineer. But when these places are established the people will have good places to settle in.

Mr. SANDERS. I have just reported from the Tongue River, where the water is brought from the Big Horn Mountains, and where the finest crops of corn, timothy hay, wheat, barley, and oats grow, such as I have not seen anywhere in Montana. That is in northern Wyoming. I was surprised that they got the water up there, and at the wonderful fertility that the hill-tops manifested after they got it there. I do not know a given lesson in irrigation that is of more interest than the Tongue River.

Senator PLUMB. Have you ever been in the Park?

Mr. SANDERS. Yes.

Senator PLUMB. Suppose we determine to maintain it as a park, as a place of resort for the purpose of the preservation of the natural objects of curiosity, would you suggest its extension? When I speak of natural objects of curiosity, I include the headwaters of the streams, game, and fish.

Mr. SANDERS. I am quite reconciled to the extinction of the rattlesnake, buffalo, and such animals as that.

Senator PLUMB. I am speaking of keeping it up. Suppose we determine to keep the Park up as a place of resort for the purpose of keeping these natural curiosities and preserving the headwaters of these streams for the fish, game, and so on, would it be desirable to enlarge it?

Mr. SANDERS. I do not know of any portion of the public domain surrounding the National Park the occupancy of which would imperil the usefulness of the Park in the particulars to which you refer. Certainly the boundaries of the National Park contain nearly all the objects of natural curiosity that there are in the country except the mountains.

Senator PLUMB. Would there be any greater water supply by the extension of the Park, so as to cover more fully the sources of that water supply and prevent their being diverted, and thereby made more accessible and useful to the people of the valley?

Mr. SANDERS. The occupancy of the public domain tends somewhat to destroy trees, and therefore limits the water supply. The headwaters of the Snake River drains very considerable forests, and the extension of the National Park or any other form of reservation over them to preserve the timber would be of some use. But I think that country contains fine valleys and is to some extent largely occupied.

The CHAIRMAN. Would it be injured by erecting small dams, so as to raise the lakes somewhat to increase the storage of water? Could it be done there without injury to the Park?

Mr. SANDERS. I think it would help the Park to enlarge the lakes.

The CHAIRMAN. You would have to draw them off during the irrigating seasons somewhat?

Mr. SANDERS. I do not see how that would injure anything.

The CHAIRMAN. Have you made any estimate, in passing over this country, of the comparative amount of land that might be irrigated and of the area that could not be?

Mr. SANDERS. I have not done so in exactly that form. I took occasion about fifteen years ago, in response to some inquiries, being pretty familiar with the topography of the country, to divide the country up

into fractions of six, saying that one-sixth was agricultural practically; two-sixths more agricultural with sufficient expenditure of money.

The CHAIRMAN. That is, was susceptible of irrigation?

Mr. SANDERS. Yes. And a sixth of it mineral, and a sixth of it timber, and a sixth of it useless, if I remember right. That is the way I took it then. I think I should revise those figures now; but I made them then as the result of my best judgment.

The CHAIRMAN. From my observation I hardly think they would need very much revision. I have been over the Territory.

Mr. SANDERS. I made those figures with some care.

Senator PLUMB. Mineral land is also timber land to some extent, is it not?

Mr. SANDERS. There is really mineral land wherever there is timber as a rule. Of course there is some mineral everywhere in the Territory. It is very hard to break off a rock within 200 miles of this Territory without on close examination finding some gold in it.

STATEMENT OF WALTER W. DE LACY, OF HELENA.

The CHAIRMAN. How long have you resided in Montana?

Mr. DE LACY. Thirty years.

The CHAIRMAN. Have you traveled over it pretty extensively?

Mr. DE LACY. Yes; I have been over it considerably.

The CHAIRMAN. What has been your occupation?

Mr. DE LACY. Surveyor and civil engineer.

The CHAIRMAN. You have made estimates of the amount of land that could be irrigated and that that could not, have you?

Mr. DE LACY. Yes. I do not so much know about what could not, as about what could be irrigated.

The CHAIRMAN. You do not know but what there might be more irrigated than you anticipated?

Mr. DE LACY. Yes. There might be more.

The CHAIRMAN. But what could be irrigated you estimate at about how much?

Mr. DE LACY. About 20,000,000 acres.

The CHAIRMAN. You do not pretend to say but what that might be largely increased by going on the other side of the mountain?

Mr. DE LACY. Yes. It might be.

The CHAIRMAN. Did you include in that area of 20,000,000 acres any land except that that would lie comparatively smooth and level?

Mr. DE LACY. Only the table-land.

The CHAIRMAN. You did not include in that the slopes of hills and rolling lands?

Mr. DE LACY. No.

The CHAIRMAN. Those might be irrigated, might they not, by terracing, when the population became dense?

Mr. DE LACY. Yes, but I did not include those.

The CHAIRMAN. If a policy of terracing the hills were pursued, that area would be much increased, would it not?

Mr. DE LACY. Yes. I will say this much in relation to that subject: that in a great many places the ground at the foot of the hills is very valuable ground for one reason, that it is apt to be very good soil, and it is not so liable to frost as that which is in the bottoms. I know that in the Bitterroot Valley—which was the earliest settled, it being settled in 1842—when people first came here they planted wheat in abun-

dance and they lost their crops very shortly by frosts. Afterward they planted their crops on the bench lands on the foot-hills, and there they found the lands infinitely better, and saved their crops. That has been the experience in that valley ever since.

The CHAIRMAN. What would you say for the general water supply of this Territory; is it extensive or not?

Mr. DE LACY. I would say that it is very good in some parts. In the western part it is generally very good, and that is a very dry country; but the water supply is generally good; better than some countries that I have seen.

The CHAIRMAN. You have quite a district of high mountains that catches the snow?

Mr. DE LACY. Yes. And there are a great many small streams as well as large ones.

The CHAIRMAN. What is your observation as to the result of irrigation in producing crops?

Mr. DE LACY. The result of my observation has been that you can not produce anything here that is worth talking about without irrigation.

The CHAIRMAN. With it, what success is there? Where it is properly conducted and the water is put on, not too much or too little?

Mr. DE LACY. The irrigation in such cases is very successful. That is to say, it makes a sure and certain crop.

The CHAIRMAN. And how is it as to the quantity or amount of the crop?

Mr. DE LACY. It makes a very large crop.

The CHAIRMAN. How are the hills as to furnishing pasture for stock?

Mr. DE LACY. They are very good indeed. I would remark that the hills are almost indispensable for sheep-raising, because they are a winter supply. The wind blows the snow away from the hills, and the consequence is that the sheep can go up there and feed; so can horses. Cattle usually do not do that.

The CHAIRMAN. There is more food for cattle, sheep, and stock in summer than in winter, of course?

Mr. DE LACY. Yes.

The CHAIRMAN. Suppose you had the valleys cultivated and the arable land under cultivation so that you had ample feed for your stock for market and ample feed for the winter, would not the amount of stock that could be raised be largely increased?

Mr. DE LACY. Yes.

The CHAIRMAN. Using these hills for the summer?

Mr. DE LACY. Yes; using the hills for the summer. And it would be very much increased by irrigation, because there would be so much more meadow-land. I have never been engaged in agriculture, but I have been engaged in sheep farming. You can take almost any bench-land—I do not care what it is—and irrigate it, and it will produce in this Territory Kentucky blue-grass.

The CHAIRMAN. Without sowing?

Mr. DE LACY. Without sowing.

The CHAIRMAN. Would it come up naturally

Mr. DE LACY. Yes. It comes up naturally.

The CHAIRMAN. Then you say that by irrigating this land in this Territory it will produce spontaneously Kentucky blue-grass?

Mr. DE LACY. Yes. It has done it, I know. It did it where I was. I know that we could get very large crops. If it was not Kentucky blue-grass, it was a grass exactly like it.

The CHAIRMAN. It is equally nutritious?

Mr. DE LACY. Yes. It is equally nutritious. Timothy grass would also grow.

The CHAIRMAN. But that has to be sowed, I suppose?

Mr. DE LACY. Yes. That would have to be sown.

The CHAIRMAN. It does now grow spontaneously?

Mr. DE LACY. No.

The CHAIRMAN. That is a very important statement, that these benches when irrigated will produce Kentucky blue-grass without the seed being sown, or a grass equally nutritious.

Mr. W. C. CHILDS. I can confirm that statement. You can see it if you take a pleasant ride 6 miles east of here.

Senator PLUMB. It comes up spontaneously, does it?

Mr. CHILDS. Yes; it is hardly blue-grass, but "blue-joint," as it is called.

Mr. DE LACY. They told me it was blue-grass, and I thought it was.

Senator PLUMB. What is the difference between that and Kentucky blue-grass?

Mr. CHILDS. This is much better than the Kentucky blue-grass.

Senator PLUMB. What is the difference in its features; what peculiarities distinguish it from Kentucky blue-grass?

Mr. CHILDS. In the early growth of blue-joint, when it first comes up in the spring, or at any time in the year when it receives moisture, it has a very close resemblance and appearance to Kentucky blue-grass, but as it advances in growth it gets to be perhaps 20 inches long, and has more the appearance of a field of growing grain. There is a seed which it produces. Stock prefer it to oats; it looks very much like grain. I think you will find the testimony universal that stock grazing upon blue-joint or bunch-grass, which in the opinion of most people is but a larger or more rank growth of blue-joint, will fatten almost as readily as they will when stall-fed.

Of course this season has been very dry. I spoke of this grass as being seen within 6 miles of here, and I did so because in that place I own the right of way, and it has not been grazed on for three years, so that you can see the grass growing in its normal state. You will see there the condition that Mr. De Lacy has mentioned. And while I do not call it blue-grass and do not understand him to call it Kentucky blue-grass, it certainly is very similar.

Mr. DE LACY. This that I speak of was very similar indeed in appearance to the Kentucky blue-grass, and the man I had with me called it that.

Senator PLUMB. Does the irrigation require to be kept up—that is, is it necessary to keep the water on the land?

Mr. CHILDS. This grass does not grow unless supplied with moisture. It is true that quite a growth obtains when there is a rainy season, but Mr. De Lacy and myself are personally acquainted with a section of the country in the eastern part of the Territory, where I can construct a ditch and supply that grass with water amply, and cut a ton and a half of it to the acre on a tract embracing perhaps 60 or 100 acres.

The grass can be seen there in its normal state, although not so profuse now as it sometimes is, because this has been a very dry season and there has been a lack of moisture.

Senator PLUMB. Is it entirely different as a species from the ordinary bunch-grass of the prairie?

Mr. CHILDS. I will not say entirely different. I have just remarked that in the opinion of many the bunch-grass and the blue-joint are identical, except that the bunch-grass is of a more rank growth. It

grows stronger and grows in bunches here and there, whereas the blue-joint covers the ground very much thicker than the bunch-grass.

Senator PLUMB. It does not make a sward?

Mr. CHILDS. No, sir, and I think that observation will confirm the statement that cultivated fields of timothy will in the course of five or six years tend to produce a grass very similar to this blue-grass. The first year's cutting or the second year's cutting is a coarse rank growth, and the third year and each succeeding year the timothy assumes a finer and thicker growth. It may be only a fancy of mine, but it seems to me as if it were tending toward blue-joint.

Senator PLUMB. How many years in succession have you known this land to yield crops by means of irrigation?

Mr. CHILDS. To my personal knowledge eighteen years.

Senator PLUMB. Each year?

Mr. CHILDS. Yes.

Senator PLUMB. Has it seemed to lose any of its fertility in that time?

Mr. CHILDS. No.

Senator PLUMB. Has the land been manured or anything given back to it besides what is taken away?

Mr. CHILDS. In some instances. It has been said that Montanaland does not need any manure. But my opinion is that it will astonish people when it is manured. If you take a field of 30 or 40 acres and let one portion of it be deprived of manure and another portion be manured, you can distinguish the results readily. Another thing, manuring of the land very largely takes the place of moisture. In other words, land which has been manured will do very much better without moisture than that which has been manured.

The CHAIRMAN. Manure preserves the moisture, does it not?

Mr. CHILDS. Yes.

The CHAIRMAN. And it prevents evaporation?

Mr. CHILDS. Yes.

Senator PLUMB. What quantity of water do you deem proper for irrigation?

Mr. CHILDS. In making any statement concerning the amount of water required for the purpose of irrigating an acre of land I always like to make a qualification, and I do so now. That is to say, what is termed a half of a miner's inch, if it is at your command whenever the land demands irrigation and you use it with good judgment, is ample; provided the land immediately to be irrigated is furnished with that amount of water whenever the demand for irrigation exists. But in practice it would be necessary to have as a rule 2 inches to the acre, because most land that is supplied with water for irrigation is supplied by ditches that are from 1 to 5 and 6 miles in length, and the water in traveling from its source, while being taken from the river to the lands to be irrigated, is subject to a great deal of evaporation as well as to seepage or soaking into the land. So that I think that for every 2 inches that start from a stream to travel through an irrigating ditch of, say, 3 miles length, before it reaches the land to be irrigated, an inch and a half of it is lost on account of bad management, by not providing the proper means to prevent loss from evaporation and from seepage.

Then, again, a very large amount of loss is sustained by the fact that the conditions are such that a man has to allow the water to run through these ditches whether he needs it or not; and when it is not being used it runs to waste, which in my opinion constitutes two-thirds, if

not a larger portion, of the time that the water is running through the ditch.

Senator PLUMB. How would you protect against evaporation?

Mr. CHILDS. Where the water is taken from a stream or reservoir, and has to be conducted a great distance to reach lands sought to be irrigated, let it be conducted in boxes or pipes or other means that will accomplish the same purpose. Box flumes would help the purpose very materially. It is well known to every one here that last month, I think it was, there was a shortage of water, and in fact there is now, in the supply to this city.

The owner of one system of water supply here (Mr. Hill) had as his private property a lake called Park Lake, some 20 miles distant from here. That lake contained, estimating the contents by its known area and depth, about 3,000,000 cubic feet of water, or nearly so. In his effort to bring it here to his reservoir which supplies the system in the city, he told me that he made an opening so as to allow the flow of 500 miner's inches, in an effort to have it travel down the ditch 26 miles long, to reach the reservoir. That water did not get to more than 3 miles from town before it had disappeared by evaporation and soaking into the ditch, as the ditch had not been used for several years.

That would show, of course, a very great loss from evaporation and seepage into the ground.

Senator PLUMB. Does not a ditch generally improve by reason of the silt in the bottom of it becoming water-proof?

Mr. CHILDS. In some cases it does, but still the water soaks through. In most cases these ditches travel through sand and gravel.

The CHAIRMAN. What is the proportionate loss between a large ditch and a small one? Of course you can not give the exact proportion.

Mr. CHILDS. A large ditch, of course, would have a larger evaporating surface, and therefore would involve a greater loss.

The CHAIRMAN. You think a large one would lose more, proportionately, than a small one would?

Mr. CHILDS. From evaporation—yes.

The CHAIRMAN. From evaporation and seepage taken together; how is it?

Mr. CHILDS. I would hardly be prepared to answer that.

The CHAIRMAN. In the experience of California, where ditches have been in use from 10 to 70 miles long, it was ascertained that the loss was much less, proportionately, where there was a large flume than a little flume. That was ascertained in practice, universally, in California, and I suppose the same thing would apply here.

Mr. CHILDS. I am not positive as to how that would be.

The CHAIRMAN. I want to finish the examination of Mr. De Lacy now. You have surveyed much of the Territory, I understand, Mr. De Lacy?

Mr. DE LACY (resuming). Yes; much of it.

The CHAIRMAN. And that brought you to travel over the mountains?

Mr. DE LACY. Yes.

The CHAIRMAN. What have you to say of the facilities of making reservoirs to store water high up in the mountains and in the mountains generally, whether high or low?

Mr. DE LACY. The opportunities are very great. I think there are hardly any regions of the country in this western section where the finest reservoirs could not be had.

The CHAIRMAN. Could they be made cheaply?

Mr. DE LACY. Yes.

The CHAIRMAN. And without the erection of costly dams?

Mr. DE LACY. Yes; without the erection of costly dams. There is a peculiarity among the mountains here; they are smooth on the summit. When you come down from one place to another they are smooth. I know that from the fact that I have taken pack trains on the summit of the mountains, and following the summit all the way down for as far as 200 miles at one time without a trail, camping over night at one of those depressions where I would find a meadow, and on either side there would be water. I had the best kind of a camp. Going down on the sides of the mountain you may perhaps immediately come to a cañon.

The CHAIRMAN. Is that true of all mountain ranges, that they have a considerable area of flat land and lakes and places where the water would be kept back?

Mr. DE LACY. Yes.

The CHAIRMAN. And that would be so in the snowy region where you could keep it longer?

Mr. DE LACY. Yes. It is very common in these ranges to have small lakes below the summit, or just immediately below. The water is of a very intense blue. They have a natural dam right at the mouth. In some instances you find the same thing but with the water gone. In that case the dam is broken.

The CHAIRMAN. By cutting down so that you can get all the water out, and by having regulating gates in the mountains, many of those streams could be increased, I suppose?

Mr. DE LACY. Yes; very much increased, indeed.

The CHAIRMAN. Suppose the Government, having reserved all those places, as it has done, and reserving the right of way for those ditches, should survey and locate them and map them, so that the people would know where they were, with a view of aiding irrigation, is there not a vast amount of land that could be cheaply reclaimed?

Mr. DE LACY. Yes, a large proportion of it.

The CHAIRMAN. Before you would deal with the great rivers?

Mr. DE LACY. Yes; before you would need to deal with the great rivers.

The CHAIRMAN. What do you say as to the value of these surveys in aiding settlers?

Mr. DE LACY. I think the surveys would be of every use in the world in showing settlers just what they could do and what can be done. It is just like anything else. A man will go and settle in a place where he sees that there is a chance to make money. It may not be such immediately, but it will be in time. People will take chances if the chances are not too remote.

The CHAIRMAN. Isn't it a fact that the people generally who live in the mountain regions are ignorant of the topography of the mountains around them?

Mr. DE LACY. Yes.

The CHAIRMAN. You have seen people contending about water and water rights when with a very little trouble and the expenditure of a very little money they could have plenty of water?

Mr. DE LACY. Yes.

The CHAIRMAN. That is very common, is it not?

Mr. DE LACY. Yes, very common.

The CHAIRMAN. I have settled many neighbors' disputes about water by directing my clients to go up a little higher and get water.

Mr. DE LACY. That could be done in very many cases where it is not done, where they are disputing about the water.

The CHAIRMAN. It is going to cost considerable money to make these surveys, and the object of this committee is to ascertain whether the work is going to be sufficiently useful to the people to warrant the expense—whether we can say to Congress that this will be so advantageous that it will enable the people to get homes.

Mr. DE LACY. There is no doubt that the surveys will be of the very greatest possible utility, and would increase immigration. They will point out to a great many men what they do not know now.

The CHAIRMAN. It is difficult for an individual farmer to find out facts as to places 30, 40, or 60 miles away from him, or as to places on the tops of mountains, and it is difficult for an investigation to be made in regard to it.

Mr. DE LACY. Very difficult.

The CHAIRMAN. It is beyond the reach of people in general and beyond their experience, is it not?

Mr. DE LACY. Altogether beyond their reach and experience. In fact people do not always understand about it when they are told about it. The farmer especially is not so apt to become acquainted with the mountains of the country as the miner is, because miners are all the time prospecting. They are going around all the time looking for minerals, and they have developed the faculty of observation keenly. When a miner is looking for minerals he is looking for everything. He will see the chance of getting water, and will mentally calculate the amount of water that will suit his purposes. I have always found that miners make the closest calculations of any class of people that I know of in regard to such matters.

The CHAIRMAN. Is it not the fact that the miner's attention was called to this question of water supply at great altitudes by reason of his finding mines in the mountains for which he required water, whether his mine was a quartz or a placer? For if a quartz mine he wanted water for his mill.

Mr. DE LACY. That is true.

The CHAIRMAN. The difference between the farmer and the miner is that the miner is more interested in looking for water than is the average farmer?

Mr. DE LACY. Yes.

Senator PLUMB. Do you know whether in the valleys along these streams there is a flow of water underground?

Mr. DE LACY. I think in many instances there is where there is gravel. I think there are a great many streams along which that would be true. A great many of our streams are running dry alternately; that is to say, there will be a stream of water for a mile or two, then the water will sink, and then it will reappear. When that is the case they are generally on a loose gravel bed. I think the reason of that is that the water percolates through the gravel and disappears, and then for some reason comes up again. That is very common.

Senator PLUMB. A rock or something of that kind may force it up again?

Mr. DE LACY. Yes.

Senator PLUMB. How deep is the water in these valleys?

Mr. DE LACY. It is generally found at bed rock, and its depth differs with the depth of the bed rock. In a great many of the streams that I am acquainted with, that are apparently dry, I think that reservoirs could be built by sinking a dam down to bed rock. Frequently you

will see a stream that is in a little cañon of perhaps 100 yards or so, and the stream may be dried up at either end of that though having water above. I think if a well were put down to bed rock the water would be forced up and there would be a reservoir, and a very convenient reservoir. Those places would be especially adapted for irrigation, because the stream comes there and has not very high banks.

STATEMENT OF HIRAM KNOWLES, OF HELENA.

The CHAIRMAN. How long have you resided in this Territory?

Mr. KNOWLES. Continuously from 1868.

The CHAIRMAN. You have been over the Territory pretty generally, have you?

Mr. KNOWLES. Yes.

The CHAIRMAN. Have you observed the effect of irrigation in this Territory?

Mr. KNOWLES. I have.

The CHAIRMAN. What do you say as to the results of irrigation?

Mr. KNOWLES. Wherever we can get water on our soil it will produce good crops.

The CHAIRMAN. What State were you from originally?

Mr. KNOWLES. I came from Iowa to Montana. I lived in Nevada a number of years, and came here in 1868 permanently. I was here in 1866.

The CHAIRMAN. What would be the comparative production, say during a period of 10 years, between irrigated land in Montana and the best land in Iowa?

Mr. KNOWLES. I will state this in relation to that: In all crops where you look to seed, like wheat, oats, or barley, this soil, if irrigated, will produce a better crop than in Iowa or Illinois.

The CHAIRMAN. A better crop than their best crops?

Mr. KNOWLES. A better crop than they average in Iowa or Illinois.

The CHAIRMAN. Do you have frequent failures when you are irrigating?

Mr. KNOWLES. We have once in a while something that is hard to account for. That is to say, we have some seasons a better crop than we have in others. But it is supposed that is owing to a lack of knowledge of how to irrigate.

The CHAIRMAN. There is danger of irrigating too much?

Mr. KNOWLES. Yes; and irrigating at the wrong time.

The CHAIRMAN. The people must find that out by experience?

Mr. KNOWLES. Yes; they find that out by experience. They have not found out that it is not proper to irrigate at certain seasons—when the grain is in a condition of formation.

The CHAIRMAN. With a view to a chance for settlers to make farms, suppose we had the country surveyed with reference to irrigation? Suppose we knew what lands could be irrigated and what could not, and that we had estimates of the cost of constructing reservoirs, etc., do you think such information would be valuable?

Mr. KNOWLES. Yes.

The CHAIRMAN. Do you think or not there could be a large amount of land in this Territory reclaimed at comparatively little expense?

Mr. KNOWLES. Oh, yes; there are large areas of land that could be reclaimed. In passing through on the line of the railroad you see only a very small portion of the land that could be reclaimed by irrigation.

The CHAIRMAN. Have you been in the habit of traversing the mountains?

Mr. KNOWLES. Yes; in early days.

The CHAIRMAN. Have you noticed that most of the mountain streams head in flats, lakes, and such places, and discharge in narrow gorges, where water could be kept back cheaply?

Mr. KNOWLES. Yes. The gorge depends upon the hardness of the rock, the strata of the mountains. You are speaking about these lakes high up in the mountains. At a point immediately west of Deer Lodge, 40 miles from here, is Mount Powell. From the summit of Mount Powell you can see 18 lakes from the mountains, and yet there are no lakes in the valleys. From the summit of Mount Powell can be seen 18 lakes, some of them a mile and a half long, and some of them a quarter of a mile. They all can be utilized in the way you speak of.

The CHAIRMAN. And some of them at trifling expense.

Mr. KNOWLES. Yes. Well, take for instance Rock Creek Lake, which is used as a reservoir for mining purposes. They have built a dam there where they raise the water for about 20 feet. There they can mine the whole season until frost comes.

The CHAIRMAN. Then with surveys might not your population be largely increased without considering the most expensive schemes of turning the great rivers along canals?

Mr. KNOWLES. Oh, certainly. Take for instance around Mount Powell. That water comes down and is appropriated, most of it for irrigating purposes, and some for mining purposes. That water comes down in a rush in the spring, and in the fall of the year or in summer, in July, there is not water enough to irrigate the land that is under cultivation. It is so with Warm Spring Creek and Race Track Creek. If that water were retained at the head in these lakes by means of a dam or gate that could be opened, we could probably irrigate twice as much land as is now irrigated along those streams.

The CHAIRMAN. Then is not the first thing to be done, not only by the people of this Territory but by the other States and Territories where arid lands are, to ascertain where water can be obtained cheaply and use that first upon the land before undertaking great enterprises?

Mr. KNOWLES. Oh, yes.

Senator PLUMB. Would it facilitate the erection of reservoirs through private enterprise or the aid of the local governments, county or State, if these surveys were not only made, but if the Government of the United States would provide the land necessary for the reservoirs and have the water accessible to the people who made the reservoirs?

Mr. KNOWLES. Certainly there could be legislation on that subject. There ought to have been long ago. Eighteen years ago I wrote to the Land Department that there ought to be reserved in every patent that is granted to a settler upon the public domain all of the water that flows over his land, except sufficient to irrigate it. It ought to be that that would be subject to appropriation. You see, under the decisions of the court up to this time, where the Government has sold land, if the water had been appropriated that flows over that land, the doctrine of riparian rights applies.

The CHAIRMAN. Does that doctrine apply here?

Mr. KNOWLES. Yes; the same as in California.

The CHAIRMAN. California went on applying the doctrine of appropriation for 36 or 37 years. Then a case arose, and they went back and imported all their facts from Scotland. The doctrine of riparian rights could not be enforced in California. The courts grant injunctions,

but the community is against it, and it cannot be enforced. It is a misapprehension of the common law. The common law is a system of principles applicable to all conditions of men, and the water to be used under these principles is for the common good. The trouble is this: the courts have forgotten that, and have gone to Europe for the facts. You must recognize this one thing—this country can produce facts, and you must apply the law and facts to the use of water. The State must do this thing. I do not know that the Government of the United States can interfere here, because there are vested rights; but the State must recognize the right of appropriation.

MR. KNOWLES. We have here a proposition pending before the convention, which is the same as the Colorado provision. It is proposed to adopt this in our constitution:

The water of every natural stream not heretofore appropriated within the State of Montana—

The CHAIRMAN. What do you mean by "appropriated"? We fought for twenty years over the question of what was meant by "appropriation," and we finally got it down to this decision—to mean for an economical use, for beneficial purposes.

MR. KNOWLES. We decided that too. But we say that—

The water of every natural stream not heretofore appropriated within the State of Montana is hereby declared to be the property of the public; and the same is dedicated to the use of the people of the State, subject to appropriation as hereinafter provided.

But here is the trouble. Right there we are prohibited from interfering with the property of the United States, and the Government of the United States holds this land. When the Government sells a piece of land, if the water has not been appropriated, the purchaser gets the water as a part of the vested rights. That is the old decision. But by legislation of Congress you can do otherwise. You can make it so that the purchaser will not get more of the water than is sufficient to irrigate his land. And that is what Congress ought to do on that subject, and relieve us from that trouble.

Senator PLUMB. In a Colorado case recently decided the question of riparian rights is known; but what we call the common law entirely disappears. There they not only take their water, so an engineer told me, out of the heads of the streams to the exclusion of the man who owns the land below, but they take it out of one valley into another.

MR. KNOWLES. Congress recognizes as long as this land is public land the right of appropriation, and recognizes the right of way over the public domain. But the Government may sell this land before this water is appropriated and the right obtained over it for irrigating ditches. In that case the party who buys the land comes in there with a doctrine that is generally attached to a purchase of land from the Government of the United States in all the older States, that the water is incident to the land. I say all do that except Colorado and California.

Senator PLUMB. What occurs in a humid valley is no authority here.

MR. KNOWLES. I rendered a decision in a case that was taken to the Supreme Court of the United States. It was denied that we could appropriate water for irrigation, but that we could for mining purposes, and that put it upon the ground of use for any beneficial purpose; and the Supreme Court of the United States sustained it.

The CHAIRMAN. You need not be afraid of the Supreme Court of the United States, because in certain decisions they have recognized this half of the continent. That court will honor the recent decisions in

Nevada and Colorado, and former decisions in California. The doctrine of appropriation will be the doctrine for arid regions.

Senator PLUMB. Let the people of this Territory memorialize Congress to give a grant for school purposes, and ask for a donation of the running water across the public lands through the Territory of Montana, provided, of course, it does not interfere with previous acts of Congress.

Mr. KNOWLES. Passing from this question of appropriation of the water: We have put in our constitution a provision that the right of way for irrigating ditches shall be considered for public use. That is the right of one man to go over the land of another.

The CHAIRMAN. That is a necessity.

Mr. KNOWLES. No; it is against all decisions. You cannot by legislation take one man's property and give it to another, for any purpose.

The CHAIRMAN. There is no decision that the taking of water in such a way is not a public use, where the community can not live without it.

Mr. KNOWLES. The use of water might be, but is the right of way?

The CHAIRMAN. If the use of water is a public use the taking of land necessary to use it is a public use. The taking of private property for a railroad is a public use, and so with water.

Senator PLUMB. There is one question which might be overlooked, which the judge evidently has in his mind. It may be necessary to use the public land which can not be obtained.

Mr. KNOWLES. The right to go over public land is already given, as long as it is public land. Now a railroad is a public agent, and it has been so decided by the Supreme Court of the United States.

The CHAIRMAN. I know it is. Why? Because the public is interested in it.

Mr. KNOWLES. No; the Government provides highways for the commerce of its people, and the railroad is a public agent.

The CHAIRMAN. But the use of water where the public could not exist without it is certainly the highest kind of public use.

Mr. KNOWLES. By that we have all the principles of common law overthrown.

The CHAIRMAN. No; you must learn to apply the principles of common law to existing facts. What is the use of applying the common law to facts that existed a hundred years ago?

Mr. KNOWLES. We have sought here to provide that where water is sold the price that shall be paid for water shall be regulated by the county commissioners.

The CHAIRMAN. Have you taken the trouble to ascertain about what proportion of the land in this Territory is within reach of water? Have you ever figured upon it?

Mr. KNOWLES. There has been a large amount; more than now. The area of the country is 140,000 square miles, and we have 90,000,000 acres.

STATEMENT OF J. C. ROBINSON, OF HELENA.

Mr. Chairman and gentlemen, I have had a good deal of experience myself with timber, by having had flumes, and I have watched that matter carefully.

Where the bulk of the wood has been cut for use in the mining countries, and it is said that is where men cut large bodies of this wood, and leave upon the ground these resinous pine boughs, and the fire gets into them and spreads and makes an immense fire, they have a deep interest in the subject, and all the men are trained to watch and use the utmost

precaution to keep fires from breaking out. And my experience with these flumes has been that the fires break out, not where men are cutting timber, but in other places. These big fires break out where timber is not used. At my flume there is a vast amount of these pine boughs scattered over the ground, and if they should make an attempt at any time to secure the timber from fire by burning up these boughs, that very act would endanger all the timber around there, because the fire would escape from the burning boughs.

The CHAIRMAN. Are fires occasioned by lightning?

Mr. ROBINSON. I do not believe they are to any great extent, although a gentleman told me two days ago that down on Elk Creek, in Deer Lodge County, a fire broke out and spread over an immense area of ground. That was by lightning. However, I think the instances are rare. But that was told to me by a reliable man, whose name I forget.

The CHAIRMAN. What would you say about a system which would have agents who reside here to control the cutting of timber, which would be permitted at a nominal cost sufficient to administer the system, as compared with the present system, where men are arrested all over the country charged with having cut timber contrary to law. For instance, there were some four or five hundred prosecutions of that kind in Arizona last year; but they failed before the jury. Would you change the system, or would you leave it as it is?

Mr. ROBINSON. I do not believe any system could be devised that would prevent careless persons setting fire to the timber. If I were hunting out in the mountains and should light a match to light my pipe or cigar and carelessly throw the match away, it would be almost impossible to have me watched to prevent me setting fire to the timber in that way.

The CHAIRMAN. Which of the systems would be the best, the one that is now in existence or the one I have suggested?

Mr. ROBINSON. I believe the system they have for prosecuting for setting out of fires is as good as you could devise, unless you make it possible to offer a larger reward to detect the people.

The CHAIRMAN. Are you in favor of arresting and prosecuting people because they cut timber on the public land?

Mr. ROBINSON. No; the prosecutions for cutting timber on the public land should be stopped.

The CHAIRMAN. What would you substitute for that system?

Mr. ROBINSON. I would let it stay as it is.

The CHAIRMAN. You would have no supervision of it at all?

Mr. ROBINSON. No; for this reason: Men will not go upon the public domain and cut timber when they have no use for it, because they have plenty of other things to do. Take the flumes where they cut annually as high as 50,000 cords of wood. Of course a man can not use all that wood himself, and he has to sell to his neighbors. Here my neighbors can not cut for themselves and they have to buy. If I want a load of wood for domestic purposes I have to hire a man to go out in the mountains and cut it for me.

There are prosecutions in Montana. I do not know how it is elsewhere, but these flume companies are cutting wood on the public land and taking it into the mining districts and selling it. They do that every day. The way we construe the law is—and I think it is the proper construction to be put upon it—wherever the timber is sold within the limits of the Territory it is for domestic purposes.

The CHAIRMAN. The courts have so held, but it has been held to the contrary.

STATEMENT OF TIMOTHY E. COLLINS, OF GREAT FALLS.

The CHAIRMAN. How long have you resided in the Territory?

Mr. COLLINS. About twenty-five years.

The CHAIRMAN. What is your occupation?

Mr. COLLINS. I am at present in the banking business, but I have been mining.

The CHAIRMAN. Your business of mining has called you pretty well over the Territory.

Mr. COLLINS. Yes.

The CHAIRMAN. Have you taken into consideration the subject of irrigation in your travels?

Mr. COLLINS. I have thought over the matter of irrigation considerably within the last few years.

The CHAIRMAN. Have you observed the results of irrigation?

Mr. COLLINS. Yes.

The CHAIRMAN. Do you pronounce it a success here?

Mr. COLLINS. Yes, an undoubted success.

The CHAIRMAN. Do you regard it a necessity to the farmers in this part of the country?

Mr. COLLINS. As a rule, yes.

The CHAIRMAN. Have you traversed the high mountains to observe their topography?

Mr. COLLINS. Yes.

The CHAIRMAN. What do you say as to the possibility of increasing the water supply by reservoirs or dams?

Mr. COLLINS. I think the water supply can be increased very much in that way.

The CHAIRMAN. Will you state your reasons for thinking so.

Mr. COLLINS. First, because the principal rain-fall is in the mountains; and secondly, because in its course from the mountains down to the agricultural lands a great quantity of it sinks into the ground, and by the time it reaches the agricultural valleys only a small portion of the natural waters of the country drained are on the surface.

The CHAIRMAN. Does not a large portion of it flow down at seasons when you are not irrigating?

Mr. COLLINS. Yes; the irrigating season in Montana is about ten weeks. That would be a maximum.

The CHAIRMAN. How as to the balance of the year?

Mr. COLLINS. The balance of the year the water goes to waste.

The CHAIRMAN. What are the facilities for retaining water in reservoirs?

Mr. COLLINS. In every section of Montana that I have been in, the facilities are excellent, both in cañons in the mountains, and in lakes in the foot-hills.

The CHAIRMAN. Are there not many ravines and small streams that run dry when they come to the valley in summer, in which by proper storing of the water they might be made useful to bring under cultivation considerable tracts of land?

Mr. COLLINS. Yes.

The CHAIRMAN. In the aggregate a good deal of land?

Mr. COLLINS. In the aggregate a good deal of land.

The CHAIRMAN. Has the attention of the people been called to that so that they have been practicing it at all?

Mr. COLLINS. No; it has not got to that extent. The people have not practiced the storage of water at all.

The CHAIRMAN. They have taken just what ran, and if there was not enough they would have a lawsuit over it?

Mr. COLLINS. That is it, exactly.

The CHAIRMAN. Where the water did not flow in the summer time, or the irrigating season, but did flow in the flood time, there has been no effort to utilize the surplusage of water for the purpose of extending the farms?

Mr. COLLINS. No.

The CHAIRMAN. What do you say of the effect of a system of surveys, where the Government would reserve the sites of reservoirs and rights of way for ditches, estimating the cost, and pointing out the best manner of working? Would such surveys and estimates be useful in encouraging settlement here?

Mr. COLLINS. It would make land now owned by the Government and which is practically worthless now, worth from \$10 to \$50 an acre.

The CHAIRMAN. It would enable the Government to dispose of large quantities of its land?

Mr. COLLINS. Yes.

The CHAIRMAN. And enable the people to make homes?

Mr. COLLINS. Yes.

The CHAIRMAN. Are you an engineer by profession?

Mr. COLLINS. No.

The CHAIRMAN. Then you can not give us any information as to the facilities for turning the great rivers and irrigating the table-lands below?

Mr. COLLINS. No.

The CHAIRMAN. Have you been over that country pretty much?

Mr. COLLINS. Yes.

The CHAIRMAN. Are those table-lands fertile?

Mr. COLLINS. Very fertile. The soil is rather "quicker" even than that in the valleys.

The CHAIRMAN. I believe that is the fact.

Mr. COLLINS. The land is somewhat warmer at a little altitude than in the low places.

The CHAIRMAN. Have you observed the growth of alfalfa here?

Mr. COLLINS. Yes.

The CHAIRMAN. Does that flourish?

Mr. COLLINS. It flourishes very much where it is seen. I have only seen it in the valleys. I have observed particularly this year, which has been an extraordinarily dry year, that four weeks ago it was cut and amounted to about 4 tons to the acre. The gentleman that cut it said that he had cut it twice and he thought he would cut it twice again before the season closed. The two cuttings together had amounted to 4 tons to the acre.

The CHAIRMAN. He would then get 6 or 8 tons altogether from it in one season?

Mr. COLLINS. Yes.

The CHAIRMAN. How many tons have you known to be produced?

Mr. COLLINS. That is the only field that I can bring to my recollection.

The CHAIRMAN. What do you say as to alfalfa as food for stock in this country?

Mr. COLLINS. It is very good food indeed for sheep, horses, and cattle, according to what I have heard from stockmen.

The CHAIRMAN. It makes good hay?

Mr. COLLINS. Very good hay.

The CHAIRMAN. They grow wheat where they can irrigate here, do they not?

Mr. COLLINS. Yes.

The CHAIRMAN. Is wheat a success here?

Mr. COLLINS. A great success. I think No. 1 hard wheat raised in Dakota and Minnesota can be raised here with great success.

The CHAIRMAN. Of wheat cultivated here, how much can be got in the ordinary season by irrigation?

Mr. COLLINS. About 35 bushels to the acre.

The CHAIRMAN. How is the ground affected by continuous cropping, under irrigation, as far as your experience goes?

Mr. COLLINS. I have never given any study to that particular branch.

The CHAIRMAN. You do not know whether the land improves or not?

Mr. COLLINS. I do not.

The CHAIRMAN. You do not know whether water has a tendency to fertilize the ground or not?

Mr. COLLINS. The farmers all tell me that it has a tendency to fertilize the land.

The CHAIRMAN. The land does not require so much manure?

Mr. COLLINS. No.

FURTHER STATEMENT OF W. C. CHILDS, OF HELENA.

The CHAIRMAN. You have already explained to us the quality of this grass called blue-joint. Have you traveled over the Montana country pretty generally?

Mr. CHILDS. I have.

The CHAIRMAN. Is there a comparatively large amount of land that can be irrigated in this Territory?

Mr. CHILDS. A very large area is susceptible of irrigation if supplied with water by the utilization of the reservoir system. The water is accessible for the purpose, too.

The CHAIRMAN. Independently of turning the great rivers?

Mr. CHILDS. Yes.

The CHAIRMAN. You stated that you had farmed in the eastern portion of the Territory. Have you ever taken into consideration the practicability of turning the Yellowstone and Big Horn and other streams upon those lands?

Mr. CHILDS. Only in a very general way. My experience in the eastern part of the Territory was of short duration, but I am engaged now quite extensively in farming in this valley.

The CHAIRMAN. From what you know of the fall of the streams and of these valleys, do you think it would be practicable?

Mr. CHILDS. From the fall of the Yellowstone and the Musselshell, the Flat Willow, and a number of others, they could be diverted from their natural course and put into canals, and would irrigate a large area, in which all classes of crops may be grown.

The CHAIRMAN. If there should not be water enough, could you increase it from the lakes above?

Mr. CHILDS. Yes. In taking out these large streams and canals and attempting to serve a double purpose of utilizing them as canals and for water reservoirs, that in my opinion could be done, sometimes at a very small cost, where you can take advantage of the natural topog-

raphy of the country; in other places by excavating and building artificial reservoirs; in some places by simply damming the gulches and depressions, and at almost any place by building entire reservoirs.

The CHAIRMAN. And thus store the flood waters?

Mr. CHILDS. Thus store the flood waters.

The CHAIRMAN. That has been done in large areas in India and other countries?

Mr. CHILDS. Yes; and it can be done here.

The CHAIRMAN. By doing that you would have water sufficient to irrigate most of the land that can be reached by these streams?

Mr. CHILDS. Yes. You can get more than double the advantage; first, by holding the water in storage, and next by stopping their annual flow at seasons when they are not used, at which times now they go to waste.

The CHAIRMAN. Your idea is that that treatment of the river would mitigate the floods below?

Mr. CHILDS. Yes; it undoubtedly would.

The CHAIRMAN. How does irrigated land compare in productiveness when well cultivated with land that has natural rain-fall in the east?

Mr. CHILDS. From my observation and information from other sources I do not hesitate to say that our crop will yield double, as an average.

The CHAIRMAN. I stated in an article in the *Forum* last April that I thought it would average that, and I was very severely criticised. I am glad to see my statement supported.

Mr. CHILDS. It can be very easily verified.

The CHAIRMAN. Can it be verified here?

Mr. CHILDS. Oh, yes, very generally.

The CHAIRMAN. You can get a crop nearly every year, can you not, with irrigation?

Mr. CHILDS. You get a crop here every year when you irrigate. The vegetation that is supplied with sunshine and moisture at the same time has, of course, the best possible chance.

The CHAIRMAN. How is it when gathering your crops?

Mr. CHILDS. Very fortunately the rainy season terminates here before harvest.

The CHAIRMAN. In planting your crops you are not troubled with rains to interfere with your planting?

Mr. CHILDS. Not to any great extent; hardly often enough to mention.

The CHAIRMAN. Could you be aided by Government surveys?

Mr. CHILDS. Certainly. A survey of the country which is so situated as to make it possible to construct reservoirs to serve the purpose of irrigating the valleys or the land below would designate the natural features so that they would come to the knowledge of all who were interested. It would astonish a great many people who have lived here for fifteen or twenty years to find out how easy it is to get water that they have been crying so loudly for. They will be astonished to find that they have not heretofore known of the existence of the water.

The CHAIRMAN. Would the Government be able to dispose of any considerable amount of its public land in consequence of such surveys?

Mr. CHILDS. I should say yes. There is a very large area of Government land which, deprived of the use of water, is practically valueless; but when supplied with water it would produce crops of a gross value of some \$50 to \$60 an acre each year. That statement can be very readily verified.

The CHAIRMAN. If such surveys can induce settlement, then you would regard them as valuable?

Mr. CHILDS. Certainly.

The CHAIRMAN. What is your opinion as to their effect in that respect?

Mr. CHILDS. I should certainly say that they would tend greatly to induce settlement.

The CHAIRMAN. That is to say, before entering on the work of handling those great rivers?

Mr. CHILDS. I should think that settlement would obtain in anticipation of the work of making reservoirs. After a surveyor had pointed out where reservoirs would be located settlers anticipating a supply of water would settle there, even if they had to suffer some privations in the mean time.

The CHAIRMAN. Would it not have the effect to induce combinations of settlers, knowing what they could do?

Mr. CHILDS. I should think so.

Senator PLUMB. What is your opinion as to the extent of the visible water supply—the amount of water precipitated and the amount that flows down the streams, and to what extent would that water irrigate the level areas?

Mr. CHILDS. I think there is ample water flowing from the source of the streams to irrigate all the land in the Territory, if properly handled and used with judgment, and at the times when the land demands it.

Referring to a particular stream which furnishes the water for this valley, the Prickly Pear stream, I am living at the head of it, and have made myself acquainted pretty thoroughly with the amount of water flowing at different seasons, and I should say that the amount of land now being irrigated from the water of that stream is about 12,000 acres. I think that in ordinary flood seasons, say from the 25th of May through to the 25th of June, which is one month, there are 50,000 miner's inches flowing; and that is a quantity of water that if reservoired, as it can be at a very small cost and held in storage, is sufficient to irrigate twice the acreage during the entire season. But what does happen for the want of this storage is that during the flood season, when not used, it rushes down and goes on to the ocean and is lost.

The CHAIRMAN. The question that Senator Plumb asked you, and the point he wanted to get at, and which I am anxious to hear you upon also, is the extent of land that can be irrigated by ordinary irrigation works in the small streams and ravines and the catchment basins that can be made without very great outlay; that is, without an outlay that is beyond the reach of settlers, providing the surveys were made and the thing pointed out. What would be the extent of land that would be reached in that way without dealing with the large rivers? Would it be large or small? In other words, what would be the amount of land that would be brought under cultivation by the utilization of the easy places of irrigation before going to any large expense?

Mr. CHILDS. There is a large amount of land that gets its irrigation from the sources you mention; that is the small mountain streams. That amount of land could be very largely increased if the local waters were held in storage.

The CHAIRMAN. Are there ravines that are not used at all where storage would enable men to make farms?

Mr. CHILDS. Yes; very many.

The CHAIRMAN. Would that be extensive in the Territory?

Mr. CHILDS. Very extensive in this Territory, if the water were held in storage at the heads of those streams.

The CHAIRMAN. So that there is a great deal of irrigation within the reach of a combination of settlers, without great outlay?

Mr. CHILDS. Yes.

Senator PLUMB. What is the average yield per acre in Montana of the different staples?

Mr. CHILDS. My judgment is that the average yield of wheat is 35 bushels to the acre on land that is well supplied with water.

Senator PLUMB. Is that spring wheat?

Mr. CHILDS. Yes; then the oats on land similarly supplied with water will yield 45 bushels to the acre. There are some sections in which the yield is as high as 75 bushels. Of course in some instances of particular cases the yield has been very much larger. But I should say the average would be 45 bushels to the acre of oats.

The CHAIRMAN. Does this country produce corn?

Mr. CHILDS. Yes; although I would not call it a country where corn would mature with certainty every year. I have corn growing on my place, and there is corn there now—stalks at least 6 feet high—table corn.

Senator PLUMB. How is it as to the crop of barley, potatoes, etc.?

Mr. CHILDS. I should say that barley would yield 40 bushels, as a good average. I would place the average yield of potatoes at about 150 bushels to the acre.

Mr. MAGINNIS. That is too small.

Mr. CHILDS. Well, I was speaking of the average. I have harvested myself as high as 400 bushels of potatoes to the acre.

Mr. MAGINNIS. A friend of mine told me that he raised 60,000 pounds of potatoes last year on 3 acres.

Mr. CHILDS. Well, my statement now is that I have harvested 24,000 pounds on one acre. But, in speaking of 150 bushels to the acre, I was giving not the largest cultivation, but an average result.

Senator PLUMB. What would be the highest yield of these different products and the lowest yield, out of which you make up this "average?"

Mr. CHILDS. In making that average, as I have already remarked, there are even instances known where as high as 100 bushels to the acre of wheat have been harvested, but only of small areas, and I have known wheat fields to yield as low as 25 bushels.

Senator PLUMB. That is the entire field?

Mr. CHILDS. Yes; the entire field; that field being very much larger than the one yielding 100. You can therefore hardly make an average without making a pro rata average.

Senator PLUMB. Take oats, rye, barley, etc.; what is the maximum and what is the minimum?

Mr. CHILDS. Putting it in that way, I should say that the maximum yield of oats would be 75 bushels to the acre; of wheat 60 bushels to the acre; of barley 60 bushels, and potatoes 300 bushels. The minimum yield I would put as follows: Oats, 35 bushels; wheat, 25 bushels; barley, 25 bushels; and potatoes, 100 bushels. It would be rare to find any place where the yields stated as minimum yields would be smaller.

Senator PLUMB. With the exception of potatoes, none of those are hoed crops. What makes the difference between maximum and minimum yield? It can not be cultivation?

Mr. CHILDS. It is the nature of the soil and the locality.

Senator PLUMB. What makes the difference in locality, with reference to the crops?

Mr. CHILDS. I think a very large difference is the result of getting bad farms, and a very large difference is due to the locality.

Senator PLUMB. What is the favorable locality and what the unfavorable in that respect?

Mr. CHILDS. That locality is most favorable, or seems so to me, which has the greatest depth of soil.

Senator PLUMB. That is a question of soil rather than location.

Mr. CHILDS. Yes; but still it is soil in a certain locality. What makes the locality more favorable is the having greater depth of soil.

Senator PLUMB. I thought by "locality" you meant the altitude or the land having some certain slope, or something of that sort.

Mr. CHILDS. I think that perhaps there is also some influence exerted by the fact of greater or less altitude. Then, with reference to the proximity to the foot-hills, I think that as a rule those lands which are called bench lands, near the foot-hills, seem to yield more largely of crops of grain; that is, those immediately in the foot-hills. Of course all of us might assign different reasons for the different quantities of yields. We seem to think that there is a greater depth of soil at the immediate foot-hill than farther down, and we think that the crop gets a better supply of natural moisture, and perhaps is protected some from the hot winds. There are various reasons that can be assigned for the difference in productiveness of different localities. The manner of seeding and taking care of the crop has great influence. The manner of irrigating has great influence. Some crops are watered to death—they are absolutely drowned—while some die for want of water. And again others suffer because they are supplied with water at improper times. There are a great many things that influence the productiveness of crops in localities.

Senator PLUMB. How often during a growing season when water has to be applied at all is it proper to apply it?

Mr. CHILDS. That depends on the nature of the soil also; in some localities where there is a subsoil of clay it will hold the water with one irrigation. Of course much depends on rain-fall and the humidity of the atmosphere. Other places having a sandy soil would require more water, because much escapes by going through the sand below the roots of the vegetation.

Senator PLUMB. Then irrigation is something of an art—it needs to be learned?

Mr. CHILDS. Indeed, that is so. You would find that to be a fact by interviewing the farmers. You would find that they would value the services of an expert irrigator at double or treble the services of an inexperienced one.

Senator PLUMB. What is the average price of these crops, reduced to bushels? You sell everything by the pound here, I believe?

Mr. CHILDS. Yes, we sell everything by the pound.

Senator PLUMB. If you cannot state it by the bushel, state it by the pound and we will reduce it to the bushels ourselves.

Mr. CHILDS. The price would vary with the market, and the question of supply and demand would also come in. The average value of oats is \$1.25 for 100 pounds.

Senator PLUMB. At the farm?

Mr. CHILDS. At the farm it would be \$1. I was thinking of the price at the market.

Senator PLUMB. I was speaking of the farm price, which I think is the best to go by.

Mr. CHILDS. The price of wheat and barley would be the same—\$1.25 per 100 pounds. I think that would be a fair average price. Of course, this year, on account of the drought, I would add 50 per cent. because of the very small amount produced.

Senator PLUMB. How is it as to potatoes?

Mr. CHILDS. Potatoes are worth here on the farm about a cent a pound. This year they will be higher. All farm products will be higher this year.

Senator PLUMB. What is the value of farm labor here?

Mr. CHILDS. I think, as a rule, farm laborers are paid \$35 a month and their board. Their board I think people generally estimate at \$15 a month, making board and wages \$50 per month.

Senator PLUMB. The man who employs a farm laborer employs him by the month and not by the year?

Mr. CHILDS. By the month.

Senator PLUMB. Some portion of the time, of course, those laborers are not employed?

Mr. CHILDS. That is so.

Senator PLUMB. As to these grains, are they drier; that is, do they contain less moisture than similar grains grown in countries where there is rain-fall? Do they make a drier flour, for instance?

Mr. CHILDS. That is a matter I could not pass judgment upon.

Senator PLUMB. Do you know whether they are a heavier grain, according to the bushel measure?

Mr. CHILDS. Yes; they are heavier. In that connection I can say this: Right in this valley were harvested crops of wheat, barley, and oats that were awarded a premium at the Centennial Exposition for quality and weight per bushel. The same grain was sent across to the World's Fair, in London, and took the premium there for quality and weight.

Senator PLUMB. Are the spring-wheat flours of Minnesota bought and sold here?

Mr. CHILDS. That I do not know.

Senator PLUMB. I want to say that in Colorado they consider the wheat raised in that country as drier and better, for crackers especially, than the wheat raised in Kansas; but the bakers nearly all buy the Kansas flour because it is more moist. While Colorado raises its own flour, still it buys a considerable quantity of Kansas and Nebraska flour.

Mr. CHILDS. I sent East considerable samples of wheat, barley, and oats, at the request of the Messrs. Lilienthal, of New York City. They handle a very large portion of California product of barley. It was really amusing to me to read their letters giving their expressions of wonder at the barley raised here. The statement has been made to me that the Milwaukee brewers offered one-eighth of a cent a pound more than for that of their own production.

Senator PLUMB. Do you raise any rye here?

Mr. CHILDS. I do not think that rye is raised to any great extent; but we can do it.

Senator PLUMB. What do you do for winter pasture?

Mr. CHILDS. We resort generally to the foot-hills.

Senator PLUMB. They have natural grasses?

Mr. CHILDS. Yes.

Senator PLUMB. You do not raise anything for winter pasture?

Mr. CHILDS. No; nothing but the natural grasses.

Senator PLUMB. Rye is very often raised in the valleys for winter pasture.

Mr. CHILDS. The question of pasture is a very peculiar one in Montana. It is simply a question of the ability of the cattle to get to the grass, which they can do if it is not covered with snow. If they can reach the grass it is sure that they will get a good living, because the grass is very nutritious. It is dry hay—"standing" hay, as we call it.

Senator PLUMB. Is there any difficulty about getting to it in the winter?

Mr. CHILDS. Yes; it is sometimes so far below the top of the snow that they can not get it.

Senator PLUMB. Then the question of winter pasture is an important one here?

Mr. CHILDS. Yes, indeed.

Senator PLUMB. Is there any fixed relation or proportion between a man's holding of land in this neighborhood and the amount of it that he can water; that is to say, can a man water all he has usually?

Mr. CHILDS. No, I think he can not, as a rule; that is, not if he makes no effort to improve on what nature has done. About 25 per cent. of the holding is the amount that can be covered by water, unless some special effort is made.

Senator PLUMB. Then the balance is used for pasture?

Mr. CHILDS. Yes; the other 75 per cent. in many instances can be covered with water out of the same stream, if the farmer would go to a slight expense and build a dam to elevate it.

Senator PLUMB. What is the value of lands in this Territory subject to ditch, where, say, one-fourth of the area can be supplied with water? Suppose, for instance, a man to have 160 acres and has water for 40 acres. What would be the value of such a farm for agricultural purposes, supposing it to have a good fence?

Mr. CHILDS. If the farm was situated where it would command a market for its products. I should say that the 40 acres covered by water would be worth ten times as much as those not covered by water, and perhaps more than ten times as much.

Senator PLUMB. What would a farm of that kind be worth generally in the Territory; that is, 160 acres of a general average value? I will get at the individual phases of it later.

Mr. CHILDS. Fifty dollars per acre, if situated where it had the command of water.

Senator PLUMB. But I mean taking the entire value throughout the entire Territory?

Mr. CHILDS. Then say \$30 per acre.

Senator PLUMB. What would be the maximum value of land of that kind for farming purposes; that is, the highest kind of land for farming, and having no other prospective value?

The CHAIRMAN. Do you mean where it is irrigated?

Senator PLUMB. No; I do not speak with reference now to irrigation particularly.

Mr. CHILDS. Do you mean the value of the whole farm?

Senator PLUMB. The whole farm of 160 acres.

Mr. CHILDS. One hundred dollars per acre, including the necessary improvements of fencing to make it a farm—with water.

Senator PLUMB. And what would be the smallest value of a farm of that kind in this Territory?

Mr. CHILDS. Ten dollars per acre.

Senator PLUMB. Then what is the difference, in value of farm products, between a farm located, say, within 3 miles of Helena and a farm

located within, say, 3 miles of Virginia City, Mont.? I am speaking now of the staple products, not vegetables.

Mr. CHILDS. I should value a farm located within 3 miles of Helena, that would produce hay, which is a staple product, at three times the value of a farm near Virginia City.

Senator PLUMB. What is the value of the product of such a farm within 3 miles of this city and one within 3 miles of Virginia City?

Mr. CHILDS. I should say double.

Senator PLUMB. That is to say, the wheat, corn, and rye and so forth would be worth here twice what it would be there?

Mr. CHILDS. No; not the grain.

Senator PLUMB. That is just what I want to get at. I want to get at the value of the product.

Mr. CHILDS. I should say there would be but a small percentage of difference in the value of the product.

Senator PLUMB. Then the market is local?

Mr. CHILDS. Yes.

Senator PLUMB. What you get here is not distributed much on the railroad, but goes directly from the producer to the place where it is consumed?

Mr. CHILDS. Yes.

Senator PLUMB. Then what is it that makes the difference between the value of a farm at Virginia City and a farm at Helena—not the difference in value of the product, since the value of the product there is nearly what it is here?

Mr. CHILDS. I would like to be understood as correcting my statement, that it would be double the value; for I understood the question to refer to the hay product.

Senator PLUMB. No. Your hay land, I understand, is a kind of bottom land which produces a hay that your arable lands do not produce. What I am trying to get at now is agricultural land. I wish to get at the value of a quarter-section of this ordinary bottom land—not hay land—of which say 40 acres are under plow and under good water, and the whole of it under cultivation and ordinarily improved. I want to get at that for the purpose of fixing the effect of the market on the different localities and comparing the value of it generally—lands in non-irrigable regions.

Mr. CHILDS. The difference in the value of lands is a result of the difference in the size of the market. That is to say, at Virginia City the supply exceeds the local demand, hence they have to send it away at a cost of transportation, which reduces the net profit to them, whereas in Helena there is nearer an equality between supply and demand.

Senator PLUMB. But I understand you to say that there is a very trifling difference between the value of wheat, etc., at Virginia City and at Helena?

Mr. CHILDS. Yes; there is not very much difference.

Senator PLUMB. Is that difference represented by a greater difference in the value of the lands; that is, are lands worth at Helena a greater percentage over the lands at Virginia City than the products of the Helena lands are worth over those of other land?

Mr. CHILDS. I think not, as agricultural lands. And I ask to be corrected about stating that they were worth twice as much.

Senator PLUMB. But you still say that lands within 3 miles of Helena, valuable only for agriculture, having no anticipation of being subdivided, were worth \$50 an acre?

Mr. CHILDS. Yes.

Senator PLUMB. Then what would it be worth within 6 or 7 miles?

Mr. CHILDS. Two or three miles would not make much difference.

Senator PLUMB. That would be the difference of cost of bringing things in, and the lack of association?

Mr. CHILDS. Yes.

Senator PLUMB. Then where would the lands be that are worth \$10 an acre?

Mr. CHILDS. It seems to be settled that the school lands would not be sold for less than that, and that makes the price for cheap lands. They would be situated off the line of railroad where the people could not get their products to market.

Senator PLUMB. They would be in isolated places?

Mr. CHILDS. Yes.

Senator PLUMB. Then, taking out the \$10 an acre lands in isolated places and coming to the lands around Bozeman, Billings, and Missoula, and the smaller places on the railroad, what would be the value of lands there within easy reach, say within 3 or 4 or 5 miles?

Mr. CHILDS. It would not be very much different from that of land here, because the freight rates are pretty small. Again, at a distance from Helena it might be found true that the land might produce larger crops to the acre, making up somewhat for the difference on account of distance.

Senator PLUMB. Are there any crop failures in this country?

Mr. CHILDS. There are no crop failures except for lack of water, except once in a while. I should say, perhaps, once in five years the grain crops which are planted late suffer from frost.

Senator PLUMB. Are there any things that might be called a total failure?

Mr. CHILDS. No; except where there is a total failure of moisture. I know that in my own case as to 100 acres of land that last year produced 45 bushels of oats to the acre, which were harvested, that very same land I purposely put in a crop late this year expecting to have water, but was disappointed; I did not get any. So that three weeks ago the growth was so stunted that I concluded it would not pay to cut it even for hay, so I turned 100 head of stock into it to eat it up, thinking that was the only way to utilize any portion of it. That was wholly because there was no water.

Senator PLUMB. Is there any total failure here except for lack of water?

Mr. CHILDS. None that I ever heard of.

Senator PLUMB. What is the effect of the hot winds that you spoke of, and where are they generated?

Mr. CHILDS. The hot winds generally come from the southwest, and are supposed to be the trade winds. But until this year they never have been severe enough to attract our attention, in the way of doing much damage. This year, however, there has been a very bad condition of hot winds. They have blown most continuously. The atmosphere has been very hot and very dry, and the fires that have been burning around us have intensified that condition. In the opinion of most people all that had the effect of taking the moisture away from vegetation rather than supplying it, if there was any in the atmosphere.

The CHAIRMAN. Even where they had plenty of water?

Mr. CHILDS. Yes.

Senator PLUMB. When are lands plowed in this climate for the purpose of agriculture?

Mr. CHILDS. Ordinarily the lands are plowed in April. Of course it depends on the early opening of spring.

Senator PLUMB. Do you ever plow in the fall before?

Mr. CHILDS. Some people plow in the fall.

Senator PLUMB. Do the lands have to be watered before they are plowed?

Mr. CHILDS. Ground that has been cultivated, generally speaking, does not have to be watered. When they are breaking in new ground they generally take occasion to break it after getting a good rain-fall. If they do not get rain-fall and insist on breaking it then they irrigate it.

Senator PLUMB. That is for the purpose of breaking the sod?

Mr. CHILDS. Yes; in the case of hard ground.

Senator PLUMB. Is it expensive to cultivate here? For example, do the hoed crops, such as potatoes, etc., need as much cultivation here as in the section of the country where there is plenty of rain-fall?

Mr. CHILDS. I am not much acquainted with the operations in the Eastern States. Farming is only a recent addition to my experience. But my observation is that there is very little labor necessary in the production of crops of potatoes on clean ground—new ground, which is apt to be clean and not foul with weeds. Potatoes need but very little labor. Irrigate them once or twice after they are hilled up and they will yield very largely—that is to say, in ground that is in good condition.

Senator PLUMB. What other kind of root crops do you raise in this country besides potatoes?

Mr. CHILDS. They raise a large beet crop. The beet crop is very large Mangel-wurzel in this Territory has produced, I think, 60 tons to the acre, where grown on good soil with good moisture.

Senator PLUMB. Does that require as much moisture as other crops?

Mr. CHILDS. I think it does, and more. We grow turnips also here; almost every kind of vegetable is grown here. It is difficult to believe one's own eyes, almost.

Senator PLUMB. Is there any food crop which could be raised in this country in fair quantity, according to the acreage, without irrigation? I do not mean to say in particular localities, but generally.

Mr. CHILDS. No.

Senator PLUMB. Have no experiments been made in that direction?

Mr. CHILDS. I do not know of anything that can grow here, generally speaking, without the aid of water. Of course, it is claimed in the north country that cultivation flourishes there without irrigation, but I venture the assertion that if the people will dig down a foot or two they will find water. It might not have been supplied from the surface, but they will find it underneath. In my belief, if you dig 7 feet anywhere you will find standing water.

Senator PLUMB. Do you mean on the bottom-lands?

Mr. CHILDS. No; on the bench lands.

Senator PLUMB. Is that a sheet of water underlying the whole bench, as you understand it?

Mr. CHILDS. I should judge so from its putting in an appearance wherever you attain that depth.

Senator PLUMB. It does not rise?

Mr. CHILDS. No.

Senator PLUMB. Does it remain at the same level, do you think?

Mr. CHILDS. Yes; although I have an artesian well there that has been flowing for about two years. That, however, is dug up in the mountains.

Senator PLUMB. At what depth did you get that water?

Mr. CHILDS. Well, to call it an artesian well needs a little explanation. I had a natural spring in a ravine at a breaking out of the mountain. I got a boring apparatus and sank a hole immediately back of the spring. The natural flow from the spring was, I should say, 5 inches of water. I sank the hole to the depth of 160 feet. At 20 feet from the surface the flow was increased quite perceptibly. At 40 feet there was perceptibly an additional flow. At 80 feet there was an additional flow, and that continued 80 feet deeper. I do not think that I added to the flow at the last 80 feet; and, having all the water that I wanted, I stopped there and put in a 3-inch pipe, and the water came up above the surface and it flows continuously out of an opening in the 3-inch pipe 13 inches above the ground. That is a 3-inch "T." And, of course, there is another 3-inch opening, to which I attached a pipe, and have taken that down the gulch for a distance of three-quarters of a mile, where it is discharged about 90 feet below its source. I have not measured the flow of that accurately, but it flows sufficiently to yield 200 gallons per minute, and has been flowing continuously for two years. It is a very good, clear quality of water.

There is one other point in that connection that I would like to mention here. That is as to the proposition of there being flowing water under the surface of the beds of streams. I know that to be true. I know that as to the McClellan stream here, which empties into the Prickly Pear above my ditch 2,000 feet, there is now water running to the extent of 25 or 30 miner's inches, while back where the water first appears in the stream it is dry up to a point where a ditch takes out all the water that would flow on the surface; demonstrating fully that the water sinks, goes under ground, and rises again to the extent of 25 miner's inches. I am now digging a bed-rock drain there and am fully persuaded from the examination and the surveys that I have made that I will get a flow of 150 inches of bed-rock water, whereas the normal flow at the surface at this season of the year, especially at this dry season, would not have been any greater than that.

I believe that it is true generally of mountain streams. That there is a very large amount of water that sinks when it is flowing through the valleys, disappears through the gravel and sand to bed-rock, and running a bed-rock drain will secure it again.

Senator PLUMB. As to your experiment with this artesian well at the foot-hills, you think there is generally an underground supply of water near those foot-hills?

Mr. CHILDS. No, I do not. I do not think that there is an underground stream of water unless you get near the bed of natural streams, near the gravel.

Senator PLUMB. There are no underground springs, then, you think, as a rule?

Mr. CHILDS. I think these springs are the results of openings which happen to occur below the level of some underground reservoir, which has resulted from the water percolating through the rocks and striking a cavity, and, being above the natural outlet, it percolates down through the seams of the rocks and makes these natural springs. I am satisfied that, as my well gave an increasing flow at 20, 40, and 80 feet, I came across streams running there at that section or depth.

Senator PLUMB. What do you say as to the relative value of agriculture here, in this part of the country, and, say, in the Missouri Valley, or the country where water is obtained by natural precipitation? How

much better off is a farmer there with 160 acres of land than a farmer here?

Mr. CHILDS. Do you mean in the productiveness of his soil?

Senator PLUMB. In the productiveness of the soil and his proximity to market, everything taken together?

Mr. CHILDS. I should say that a farmer here with 160 acres of land, with water for irrigating the same, is 400 per cent. better off than the other farmer. That is, he is four times better off.

Senator PLUMB. That is to say, taking his market, and the certainty of his crops, and the larger amount to be raised, and so on, you think he is four times better off here?

Mr. CHILDS. I should judge so as an average.

W. A. BURLEIGH. Ask Mr. Childs, Senator, as to the size of the potatoes that he has seen growing here.

Mr. CHILDS. My reputation for veracity is very well established, but I will venture one other assertion. I have seen potatoes dug and put on the scales that weighed $5\frac{1}{2}$ pounds each.

Senator PLUMB. That, of course, is not the average weight.

Mr. CHILDS. There is a very large percentage of a certain variety of potato that will go to a pound and a half. I think there have been harvested patches of potatoes to the extent of one or two or perhaps five acres of certain varieties that will average $1\frac{1}{2}$ pounds apiece.

Senator PLUMB. Do you produce onions here?

Mr. CHILDS. Yes, from the seed; onions that excel the Bermuda onion.

Senator PLUMB. They are flavorless, are they? More like the Spanish onion?

Mr. CHILDS. There are different varieties, having different flavors. The kind I had reference to is nearly flavorless.

STATEMENT OF W. A. BURLEIGH, OF HELENA.

The CHAIRMAN. How long have you resided in Montana?

Mr. BURLEIGH. About eleven years.

The CHAIRMAN. You have lived in Dakota a long time, too, I believe?

Mr. BURLEIGH. I went to Dakota in 1861 and resided there till I came here, about eleven years ago.

The CHAIRMAN. You represented Dakota as a Delegate to Congress?

Mr. BURLEIGH. Yes, for four years.

The CHAIRMAN. Has your attention been called to this subject of farming by irrigation?

Mr. BURLEIGH. I have devoted a great deal of thought to the subject. I was one of the gentlemen who, some time ago, suggested the matter to the people here.

The CHAIRMAN. Have you traveled over the Territory considerably?

Mr. BURLEIGH. The eastern portion of it I have, but not the mountains. The Yellowstone Valley and its tributaries I have been over a good deal.

The CHAIRMAN. What is your observation on irrigation and its success?

Mr. BURLEIGH. So far as I have witnessed it it is a present and perfect success. In fact the country is perfectly worthless for agricultural purposes without irrigation.

The CHAIRMAN. With irrigation how does it compare with land you

have been in the habit of seeing cultivated in Dakota and other places further east?

Mr. BURLEIGH. With irrigation the soil of the Yellowstone Valley, in eastern Montana, will in my judgment produce larger crops than any country that I ever knew anything about.

The CHAIRMAN. To what extent is irrigation practicable in the eastern portion or eastern half of this Territory?

Mr. BURLEIGH. With proper reservoirs to save the water that runs down in the spring, I believe that more than one-half of eastern Montana is susceptible of irrigation.

The CHAIRMAN. What is the character of the soil as to fertility?

Mr. BURLEIGH. The soil is very fertile indeed, provided it has water. Without water it is not. I should like to make an observation at this point, if I should be allowed to do so.

The CHAIRMAN. Make any statement you wish without waiting for questions.

Mr. BURLEIGH. I know of three of the best farmers in eastern Montana who live in the Yellowstone Valley, and all of them on the other side of the railroad. They went there with from \$12,000 to \$20,000 apiece. They undertook to cultivate the soil without irrigation, and two of the three told me that had it not been for their stock they would have been bankrupted. Then they got together and took out a ditch just below Custer Station on the opposite side of the river, by their own efforts, and are now making the ditch larger to irrigate thousands of acres out of the Yellowstone River.

I have seen blue-grass with irrigation grow 30 inches high, and in my judgment if it had been cut it would have produced 3 tons to the acre. I know it is Kentucky blue-grass because I sent to Kentucky and got the seed. I have seen larger timothy grow with irrigation on the bottoms, larger clover and larger alfalfa than I ever saw grow in any other country.

The CHAIRMAN. Can the Government facilitate irrigation by making surveys?

Mr. BURLEIGH. Yes; if the Government surveys are made under scientific direction. People will then have confidence in the country, and if arrangements are made by which even private enterprise can engage in irrigation under the direction of a competent Government engineer, I think it will very largely benefit the country.

The CHAIRMAN. To what extent can land be brought under cultivation by private enterprise, probably, if parties had all the facts with regard to the particular localities?

Mr. BURLEIGH. All the land susceptible of cultivation lying below the head of the water.

In regard to the storage of water, there are hundreds of little streams in this Territory that are full of water from melted snows and rains of the spring. There are natural reservoirs where that water in very many instances can be saved to be used during the dry season and when these springs are dry. If that system could be adopted there, it seems to me it would add immeasurably to the wealth of the country and the people. I do not "think" anything about it; I know it.

The policy of the Government has been one of the most peculiar kind. Long since steam-boat navigation has ceased here the Government has continued to make appropriations to improve the navigation of these upper rivers. Navigation of these upper rivers is a thing of the past. They drain the water out as rapidly as possible, so that it shall not stay very long if they can help it. And when the waters are going down to

the lower country the policy of the Government tends to make it worse. Then they start to build jetties below to let it out of the Mississippi. Whereas if the money were expended up here—some such measure as you suggest—it would be of immeasurable benefit to this whole country.

The CHAIRMAN. Do you believe it would mitigate the floods if the waters were stored up here, as you think they might be?

Mr. BURLEIGH. Certainly it would. The water being turned upon the soil here would promote evaporation and increase the rain-fall. Take the Missouri River; when it starts out of the boom in June it causes the greatest consternation. If you turn the water from those water-sheds on to the country below, inundations are inevitable. The clearing out of the channels here has a tendency to send the water down as quickly as possible. I have been thinking this thing over seriously in the light of common sense, and I have wondered whether we are really advancing in intelligence as a people or whether we are not degenerating ever since the days of the old Egyptian monarchs, who first conceived the idea of converting the great Egyptian desert into the granary of the world.

The CHAIRMAN. Undoubtedly the world has largely lost a knowledge of the art of irrigation; but it is recovering it.

Mr. BURLEIGH. Our people should endeavor to regain some knowledge of it. I would like to say a word or two now to the committee with regard to the timber land.

The CHAIRMAN. Condense what you have to say into as small a space as possible, as our time is limited.

Mr. BURLEIGH. My idea is that the system of employing secret agents, which has been pursued by the Government here, has been very detrimental to the people of this country and should not be continued. I think there should be a Government agent here to supervise the timber.

The CHAIRMAN. Would you allow every person, under proper regulations, to cut what timber he required?

Mr. BURLEIGH. Yes; and the thinning out of the timber will be an advantage. It would be better for the forests and for this people if about nineteen trees out of every twenty were cut down; but care should be taken to cut down the right trees and to leave the right trees standing. The growth is now so dense here that the wood takes the moisture from the ground, and the forests actually perish. There would be moisture enough to sustain about one tree in twenty and bring it up to a large size; so that really the forests ought to be somewhat denuded.

In regard to forest fires, I have some peculiar views, and I think they are founded in fact. As you came up from Miles City you found that there had been fires between the railroad and the river.

The CHAIRMAN. Yes.

Mr. BURLEIGH. That is all occasioned by the miserably incompetent appliances used by the railroads on their locomotives. I venture to say that forty-five fires out of every fifty that have occurred in the West, and that have devastated and that are now devastating the country, have come from incompetent devices which the railroad companies have employed upon their locomotives, so that cinders and sparks have been thrown off without limit. There has been more timber destroyed by fire in the Territory of Montana, as Colonel Sanders has said, since the first day of last July than has ever been consumed by settlers in this Territory. The same applies to the grass. We are annoyed to death by the burning of the grass. Many railroads will not even keep the combusti-

ble material off their right of way. I make that suggestion in no unfriendly spirit against the railroads, but I state the fact.

The CHAIRMAN. Anything that the Government can do will, I think, be done, so that the people can have the timber, and at the same time not interfere with the growth of the forests. But the matter of keeping the land from fires is a most important one.

Mr. BURLEIGH. From Lake Superior to Puget Sound the Government has donated to the railroads a great belt of country 40 miles wide, and it is nothing more than right that the railroads should be required under the strictest laws to protect the settlers and the country against devastation by fire.

The CHAIRMAN. I think the States separately might pass laws on that subject also.

Mr. BURLEIGH. I think our people will do so when they have a State government. We have a provision in our new constitution sufficient to cover the subject. Of course there should be some modification of our land laws here, but that can be suggested as we go along. This thing of sending Pinkerton's detectives here to hound down our people is villainous and should not be continued.

STATEMENT OF G. C. SWALLOW, INSPECTOR OF MINES FOR MONTANA.

The CHAIRMAN. How long have you resided in Montana?

Mr. SWALLOW. I have been practically here since 1867, though I have been away sometimes.

The CHAIRMAN. Has your attention been called to the subject of irrigation?

Mr. SWALLOW. Somewhat.

The CHAIRMAN. Have you traveled over the country here to observe the topographical features and conditions bearing on that subject?

Mr. SWALLOW. I have seen the whole country. I am inspector of mines for the Territory, and I have traveled a good deal through the Territory.

The CHAIRMAN. What do you say as to the opportunities for irrigation in this Territory?

Mr. SWALLOW. I think there is water enough in the Territory now to irrigate all the arable land we have.

The CHAIRMAN. About what proportion of the land would be arable land?

Mr. SWALLOW. One-half.

The CHAIRMAN. And there is water enough to irrigate that?

Mr. SWALLOW. I think there is water enough, if it is properly managed, to irrigate half of this Territory.

The CHAIRMAN. What do you say about the storage of water in reservoirs to save it for the time of irrigation—whether that could do very much?

Mr. SWALLOW. That will have to be done. We can not irrigate one-sixth of it now.

The CHAIRMAN. What are the facilities for storing the water in connection with the topography and the streams?

Mr. SWALLOW. I never knew any country that had so many facilities as this for that purpose. All the mountains are full of ravines and places for reservoirs.

The CHAIRMAN. Steep ravines are not good. Are there marshes and flat places adapted for reservoirs?

Mr. SWALLOW. Yes; all our mountains are full of them.

The CHAIRMAN. Are there many places where sufficient water does not now come down the ravine or steep, but where by storage enough water could be had?

Mr. SWALLOW. Yes; I have been over Judith Mountain, and I am surprised to see that all the mountain streams are flowing. The streams where they open out into the valley are dry. I will mention one which they call "Dry Wolf," because it does not flow. I traveled up that valley several miles, and for 3 miles there were 500 inches and for several miles 800 inches of water. There was really plenty of water to irrigate the farms, if the farms could get it, but it sinks.

The CHAIRMAN. Can it not be taken out by ditches, high up, or by flumes or pipes, or other means that might be resorted to?

Mr. SWALLOW. Of course; there is no trouble about it whatever.

The CHAIRMAN. What is your opinion as to the value of surveys for the purpose of irrigation and locating reservoirs and ditches and estimating the cost thereof, and how much would that benefit the country?

Mr. SWALLOW. It would fill this country up. People do not know now what it is going to cost them, and until they do know they will not get water. If you give them the information and make it certain that they can get water, they will settle here.

The CHAIRMAN. And in many cases they will get the water themselves?

Mr. SWALLOW. Yes; if they know how and where.

The CHAIRMAN. Is it expensive for individuals to find out where and how?

Mr. SWALLOW. They do not know enough now. They have to come here and hire an engineer and pay him \$10 a day and his expenses, and they do not know where to send him when they find him.

The CHAIRMAN. Consequently they do not know where the irrigation can be had that is easy to be had?

Mr. SWALLOW. No. At one time I met a colony of Swedes up in the Judith Mountains. The country was very dry, and they thought they would go out prospecting. They went along for 8 miles in the valley, and there they have built, and have now water enough. The grass in that valley in some places is as high as my knees. There are hundreds of square miles in those mountain valleys that are full of grass.

I have been listening here, and I see your attention has been given to this question of mountain reservoirs, but apparently altogether for agricultural purposes. I want to make a suggestion if you will allow me.

The CHAIRMAN. Certainly.

Mr. SWALLOW. Does the province of your committee include the supply of water for mining purposes?

The CHAIRMAN. That will come in incidentally; but the miners are a pretty shrewd class of people and are very apt to regulate their matters pretty successfully themselves.

Mr. SWALLOW. I know that; but if you go up into these mountains to regulate all these matters and take away the water from the miners and give it all to the farmers that might not be just the proper thing to do. Can you not regulate it so that the miner can be protected the same as the farmer?

The CHAIRMAN. Certainly; the miners will be protected.

Mr. SWALLOW. They have themselves built a great many reservoirs to save the water.

STATEMENT OF ALFRED MYERS, OF BILLINGS, PARK COUNTY.

The CHAIRMAN. What is your business?

Mr. MYERS. I have been stock-raising and farming in Park County.

The CHAIRMAN. Have you looked into the subject of irrigation and the matter of fertilizing the land by putting water on it?

Mr. MYERS. Yes; I have given considerable thought to that, and have had considerable experience of it in farming.

The CHAIRMAN. With what success?

Mr. MYERS. Very satisfactory success, as far as I have been able to conduct the water to the land.

The CHAIRMAN. Have you had large crops?

Mr. MYERS. Yes; I have had a large yield and a certain yield on the land which I have been cultivating.

The CHAIRMAN. To what extent can irrigation be practiced in this part of the country, do you think?

Mr. MYERS. I think all along the base of the mountains and on the plateaus on the eastern part of the Rocky Mountains it could be practiced very extensively by a system of reservoirs for storing the water and conducting it on to the table-lands. It would be very successful and profitable.

The CHAIRMAN. How would Government surveys be regarded in that connection.

Mr. MYERS. They would be very material in pointing out to the people the manner in which a system of reservoirs could be used for the storing of water, and the probable cost of their construction and so forth. That would very greatly help the reclaiming of the arid lands.

The CHAIRMAN. And you think one-half of the country east of here could be irrigated?

Mr. MYERS. Yes; I think so.

The CHAIRMAN. What variety of crops can you raise here?

Mr. MYERS. Oats, wheat, barley, rye, potatoes, and all kinds of vegetables. They raise a very fair quality of Indian corn. Hay is a success here, and the grasses, alfalfa, timothy, clover, blue grass, and so forth, also.

The CHAIRMAN. Suppose that the land that could be made subject to irrigation were generally under cultivation here, would that be valuable?

Mr. MYERS. Yes.

The CHAIRMAN. How does the summer range compare with the winter range in this country? Is there more summer range than winter range?

Mr. MYERS. Yes; a great deal more.

The CHAIRMAN. Suppose you had forage for your stock in winter, and feed to fatten them, so that you could send fat sheep, fat hogs, and fat beeves to market, would the balance of the land be valuable for your summer range?

Mr. MYERS. I think it would; it would enhance the value and make a demand for this land that was not adapted to winter grazing.

The CHAIRMAN. Would it not furnish additional advantages, over almost any other country, to those who had irrigable land, by enabling them to have pasture land for the summer?

Mr. MYERS. I think it would. It would place this country in a very favorable condition compared with others.

The CHAIRMAN. Is there any section of the country east of here with which you are familiar that would have equal advantages?

Mr. MYERS. No, sir; not after you get out of the Rocky Mountains—after you get off these table-lands.

The CHAIRMAN. I mean as to the rich lands of the Mississippi Valley—would farming be conducted there with the same profit that it could be here?

Mr. MYERS. I think not. I think farming here, where an abundance of water can be procured, would be more successful than it would be there.

The CHAIRMAN. How do the crops compare here with the crops East; for instance, in Illinois, or whatever State you are familiar with?

Mr. MYERS. I am familiar with all the States. I have lived in Illinois, in Missouri, in Iowa, and other States. In small grains, I think we can produce more to the acre here than in any other of the central Middle States.

The CHAIRMAN. And are more sure of a crop?

Mr. MYERS. Yes.

The CHAIRMAN. Taking it for ten years, how do you think it would be?

Mr. MYERS. It would be more certain here, with a supply of water. In these lands there are very few seasons in which we can procure a good crop without irrigation. The rain-fall does not come exactly at the right season and does not continue long enough. In the case of these arable lands we scarcely ever have rain enough during the season to produce a crop. A gentleman spoke of the northeastern part of the Territory. That, perhaps, has some land that in some seasons would produce crops without so much rain as the land here, but there is no certainty of the supply of crops here without artificial irrigation.

The CHAIRMAN. Are there any other particular facts that you would wish to state?

Mr. MYERS. Nothing further than to say that I think it is entirely practicable to reservoir and store the water along the base of the mountains. Of course there may be places west that would be equally practicable, but the large extent of country that is adapted to the storing of water is on the eastern base of the Rocky Mountains.

You suggested the idea about reclaiming the National Park. You are going to make all this timber region a national park virtually. You might enlarge westward the National Park a little without any injury to any other interest, perhaps, but in any other direction you will be apt to get into a valuable mining country.

STATEMENT OF SIMEON S. HOBSON, OF HELENA.

The CHAIRMAN. How long have you resided in Helena?

Mr. HOBSON. I have resided here for ten years.

The CHAIRMAN. Have you given the subject of irrigation some attention?

Mr. HOBSON. Yes.

The CHAIRMAN. Are you a farmer?

Mr. HOBSON. Yes; and a stock-raiser.

The CHAIRMAN. Where?

Mr. HOBSON. In the Judith Basin.

The CHAIRMAN. What are the facilities in this Territory for irrigation?

Mr. HOBSON. They are very good in the valley in which I live.

The CHAIRMAN. Have you examined the Territory generally?

Mr. HOBSON. To a considerable extent I have. It is a large Territory, however.

The CHAIRMAN. From your observation, about what proportion of it might be irrigated if the water were stored and saved?

Mr. HOBSON. I should not think that over 25 or 33 per cent. of the Territory. The mountain ranges are very large in this Territory.

The CHAIRMAN. If you take the eastern part, how much would it be?

Mr. HOBSON. Perhaps one-half of that might possibly be irrigated in that way. The valley in which I live is a large valley, and one-half of that certainly could be irrigated.

The CHAIRMAN. How much is under cultivation in your valley; what proportion of the land?

Mr. HOBSON. Not over 5 per cent., I think. It is difficult to estimate correctly. The people use all the land they can find along the bottoms of the streams, about as wide as they can conveniently get the water to, but there is a good deal of water taken out with small ditches.

The CHAIRMAN. Have you taken any means to increase the water supply at all except taking what flows down at the time you want to use it?

Mr. HOBSON. No other.

The CHAIRMAN. Have you examined the places above to see whether there are opportunities for storage?

Mr. HOBSON. Yes; and there are very fine opportunities. We are entirely surrounded by mountains that are not very high nor very steep.

The CHAIRMAN. Are there any lakes or flat places above?

Mr. HOBSON. Yes.

The CHAIRMAN. Has there been any system adopted in your valley of taking out the water above by a large ditch and bringing it down and distributing it?

Mr. HOBSON. No. There is a great deal of fine bench land in that basin that could be irrigated with a proper system of reservoirs. I do not think there is a body of land in the Territory that is as well adapted for that.

The CHAIRMAN. What kind of crops do you produce there?

Mr. HOBSON. Principally oats.

The CHAIRMAN. Can you produce all the small grains?

Mr. HOBSON. Yes; but we have no market for it.

The CHAIRMAN. But the valley can produce it?

Mr. HOBSON. Oh, yes.

The CHAIRMAN. Can you produce all of the vegetables?

Mr. HOBSON. All of them.

The CHAIRMAN. Can you grow alfalfa?

Mr. HOBSON. Yes. I have 20 acres of alfalfa.

The CHAIRMAN. How does it do?

Mr. HOBSON. It grows very finely.

The CHAIRMAN. About how much a year can you get from an acre?

Mr. HOBSON. About six tons to the acre each year.

The CHAIRMAN. You find it valuable food for cattle, do you not?

Mr. HOBSON. The best we have ever had. I do not think the subject of alfalfa raising is generally understood in this country. My experience and that of my neighborhood is that it only does well on ground that requires irrigation. Ground that is so low that it requires no irrigation does not do well for alfalfa. I am really the only man in my county that has been successful with alfalfa, and that accounts for it. The others put it on low ground.

The CHAIRMAN. Have you tried fruits?

Mr. HOBSON. Nothing but small fruits. We raise plenty of strawberries, currants, and such things.

The CHAIRMAN. Are there any other suggestions that you desire to make?

Mr. HOBSON. Nothing further, but that I think if a system of Government surveys were made a great many farmers would club together and take advantage of the information, if they knew just where to apply it.

The CHAIRMAN. It involves considerable risk, you think, for private individuals to hire surveyors to make preliminary surveys?

Mr. HOBSON. The business of raising crops in this country would not pay for the employment of that class of skilled labor. The great drawbacks to agriculture in this country are the high prices of labor and the scarcity of water. I do not think any agricultural country was ever developed thoroughly with labor at \$40 a month.

The CHAIRMAN. Labor can earn, and you can afford to pay, \$40 a month, provided you could raise first-class crops.

STATEMENT OF CONRAD KOHRS, OF HELENA.

The CHAIRMAN. How long have you resided in this Territory?

Mr. KOHRS. Twenty-seven years.

The CHAIRMAN. What is your occupation?

Mr. KOHRS. I am farming and stock-raising, and have been engaged in placer mining for many years.

The CHAIRMAN. You are quite familiar with this Territory?

Mr. KOHRS. Yes.

The CHAIRMAN. Have you given attention to irrigation?

Mr. KOHRS. Yes.

The CHAIRMAN. Of what advantage to the people here would a system of Government surveys be that would indicate the places for reservoirs and the rights of way for ditches, and that would estimate the cost of such?

Mr. KOHRS. It would be a great benefit for our country, because the people would learn of the facilities they have for storing water, which they do not know anything about now.

The CHAIRMAN. If that was done, is there a large amount of public land that would be brought under cultivation?

Mr. KOHRS. A very large amount.

The CHAIRMAN. What proportion of the land in the Territory do you think could be irrigated if the water were used properly?

Mr. KOHRS. I think that you could increase the agriculture of this Territory by twenty times as much as its present output if you had the water properly distributed. I do not think that more than 5 per cent. of the arable land is under cultivation now.

The CHAIRMAN. Have you ever been over the plains east of here on the table-lands?

Mr. KOHRS. Yes; I am well acquainted with the entire Territory.

The CHAIRMAN. What is the character of those table-lands, taking the whole range east of here?

Mr. KOHRS. I am not so very well acquainted with the Yellowstone country as Mr. Myers is; but, taking it north and northeast, it lies well for irrigation. The most of the country there has a clay sub-soil. There is no country in Montana that lies so favorably for storing water as the northeastern part, because all over the country there are

natural lakes in which water can be stored without great expense. That is less true of the southern part of the country.

The CHAIRMAN. If the land that can be irrigated were irrigated and cultivated, what would you do with the remainder of the land?

Mr. KOHRS. There would always be a great deal left for grazing. I think the extent of grazing is larger than most people have any idea of.

The CHAIRMAN. If you had forage for the winter, so that you were not under the necessity of keeping cattle during that season unless the winter was an open one and unless it was convenient to do so, you could fatten them, and there would be a vast amount of land, would there not, that you could use for grazing?

Mr. KOHRS. Yes; there would be a great deal left for good summer grazing; that is, if the water-courses were not shut off from our cattle.

The CHAIRMAN. On the contrary, would not the water-courses, if the waters were taken out, afford better facility for getting at the water?

Mr. KOHRS. No, I do not think so; because you would find that the larger portion of the land would be under fence and the creeks would be dry and the cattle naturally would have to go farther for water.

The CHAIRMAN. Would it not be easy to take lateral ditches out and let the cattle have water that way?

Mr. KOHRS. Yes.

The CHAIRMAN. Would it not make a good base of supply, properly managed, so that they could go farther back and occupy a larger area of country?

Mr. KOHRS. Yes; it could be done in that way.

The CHAIRMAN. So that you could employ the arable land and the pasture land both?

Mr. KOHRS. Yes; we would have a very fine country, provided the farmers could go and get a market for their products. At present we are pretty far from transportation in some parts of the Territory.

The CHAIRMAN. Suppose that Montana were a meat-producing country, transportation of dressed beef ought not to be very heavy?

Mr. KOHRS. No; it is not in comparison very heavy, as in the case of grains.

The CHAIRMAN. It seems to me that this should be a great meat-producing country, and then your distance from the market would not be a great drawback.

Mr. KOHRS. It would not, if we could break up that ring in Chicago.

IRRIGATION INCORPORATIONS IN MONTANA.

The following list was furnished the committee by the secretary of the Territory:

Boulder Valley Ditch, Mining, and Milling Company; principal place of business is in Boulder Valley, Jefferson County, Mont.; filed in the office of secretary of Montana, January 22, 1876.

Big Spring Water-Ditch Company; principal place of business is Helena, Lewis and Clarke County, Mont.; filed in the office, of secretary of Montana, January 15, 1883.

Cañon Ditch Company; principal place of business is Dillon, Beaverhead County, Mont.; filed in the office of secretary of Montana, May 8, 1888.

Eldorado Ditch Company; principal place of business is Choteau, Choteau County, Mont.; filed in the office of secretary of Montana, September 10, 1883.

Moreland Ditch Company; principal place of business is Hamilton, Gallatin County, Mont.; filed in the office of secretary of Montana, September 5, 1882.

Miles City Irrigating and Ditch Company; principal place of business is Miles City, Custer County, Mont.; filed in the office of secretary of Montana, December 26, 1885.

Surprise Ditch Company; principal place of business is Corvallis, Missoula County, Mont.; filed in the office of secretary of Montana, March 30, 1885.

Republican Ditch Company; principal place of business is Corvallis, Missoula County, Mont.; filed in the office of secretary of Montana, May 3, 1886.

Ryan Ditch Company; principal place of business is in the counties of Yellowstone, Custer, and Dawson, Montana; filed in the office of secretary of Montana, September 24, 1885.

The Belt Creek Land and Ditch Company; principal place of business is Choteau County, Montana; filed in the office of secretary of Montana, December 15, 1883.

Tongue River Irrigating and Ditch Company; principal place of business is Miles City, Custer County, Mont.; filed in the office of secretary of Montana, August 22, 1882.

The Italian Ditch Company; principal place of business is Park City, Yellowstone County, Mont.; filed in the office of secretary of Montana, September 15, 1886.

The Deseret Ditch Company; principal place of business is Powersville, Custer County, Mont.; filed in the office of secretary of Montana, May 3, 1886.

The Miller Creek Ditch Company; principal place of business is Missoula, Missoula County, Mont.

The Beaver Creek Ditch Company; principal place of business is Warm Springs, Jefferson County, Mont.

Union Ditch Company; principal place of business is Dillon, Beaverhead County, Mont.; filed in the office of secretary of Montana, June 6, 1887.

Ward Ditch Company; principal place of business is Corvallis, Missoula County, Mont.; filed in the office of secretary of Montana, June 4, 1888.

STATEMENT OF WILLIAM F. WHEELER, C. E., OF HELENA.

In 1883 I wrote for the Interior Department an article on the forestry of Montana at the request of Mr. Furness, a commissioner on forestry, etc., which paper was published, I think, in the Agricultural Report. I had been United States marshal nearly ten years and had traveled over the country, and gave the result of my observations on our forests. This spring I have also written a report on the same subject for the Bureau of Statistics of the Treasury Department at Washington, which will most probably be published in one of its quarterly reports. I here make a synopsis of my observations and conclusions for your committee.

The area of the timber-lands of Montana is estimated at about 35,000 square miles. The distribution of timber is confined mostly to the great mountain ranges, their spurs, and detached clumps of mountains.

The densest, most extensive, and valuable bodies of timber lie in the part of the Territory west of the Rocky Mountains. In size and appearance the trees here partake of the Washington Territory and Oregon type, while the trees east of the mountains resemble in appearance and growth their congeners of the Atlantic coast. This difference is accounted for by the fact that the clouds that are driven eastwardly from the Pacific Ocean discharge the greatest part of their moisture against the sides of the mountain ranges facing towards the ocean.

The eastern slope of the main range, the several spurs branching from it and running parallel with it frequently for one or two hundred miles, and the several detached ranges and clumps of mountains which often stand alone far out on the plains, are covered with a fair growth of valuable forests and supply a large area of country adjacent to them.

There is practically no hard timber in Montana, as oak, ash, hickory, etc. Trees do not grow in the valleys or on the great rolling prairies east of the mountains. The plains are treeless. However, along the margins of all the streams there usually grows a narrow fringe of poplar, cottonwood, quaking asp, alder, and willow. It makes very inferior lumber, and it is mostly used for fuel and fencing. Railroads now traverse every principal valley of the Territory, and the supply of lum-

ber for building purposes is ample, and is sold at moderate prices. Coal is found in every county, and of however inferior a quality in some districts (its quality is generally excellent) it forms a cheap and an abundant fuel, especially in the plains or prairie portions of the country.

The extensive and almost exclusive use of barbed wire for fencing saves annually millions of feet of lumber and small trees. So, with these substitutes for timber (coal and barbed wire), the present growth of timber will not be exhausted for ages to come, unless destroyed by forest fires.

The smelting-furnaces and quartz-mills use a large amount of wood annually for fuel and in the form of charcoal. A great deal is also used in timbering up mines. For sawing into lumber and shingles and for making railroad ties, piles, and for trestles much is consumed. In this manner I estimate the consumption of last year at 150,000,000 feet, board measure.

The greatest destruction of timber is by the extensive forest fires that occur occasionally. These were notably destructive in 1869, 1873, and 1886. But that raging at the present time covers a greater area of mountains, and I believe will be the most destructive Montana has ever experienced.

Our local laws for the prevention of forest fires are excellent, but there are no special officers to enforce them, and witnesses to an overt act are seldom found.

In my opinion the best way to preserve our forests would be to survey them into small lots and sell them out to our people. The law should regulate the cutting of the timber, so as to prevent all being cut off of any tract, at any time, so that there may be continually a new growth.

One fact in my observation is very gratifying, that is, that a new growth of timber springs up almost immediately after the timber has been cut or burned off, and, if not molested, will produce a growth as large as the old one in the same time. I know of mountain sides now which were burned over twenty years ago where the new growth is from 15 to 25 feet in height.

The first water ditches constructed in Montana were for the purpose of washing the sands and gravel bearing gold along the various bars and gulches where it was found. A great number of these ditches were built from 1862 to 1869. According to the only record preserved, viz, The Statistical Almanac of Montana for 1869 (the only one ever published), there had been up to the end of that year $287\frac{1}{2}$ miles of mining ditches constructed at a cost of \$806,500.

Their total capacity was 35,370 miner's inches, at a steady flow under 6 inches of pressure. The longest ditch mentioned was 50 miles in length, cost \$15,000, and had a capacity of 1,500 inches, and the shortest $1\frac{1}{4}$ miles long, with a capacity of 4,000 inches. It cost \$2,500. The difference in cost of water ditches depends entirely on the nature of the country through which they are built. Where it is rocky or precipitous the expense is greater. In a prairie or valley the cost is at the minimum.

The purposes for which these ditches were built have been answered. The ground which they covered is generally exhaustively mined out. A few places are still mined with fair results, but the poorer diggings are leased to Chinamen, who are satisfied with small profits. As a matter of course, the ditches have decreased greatly below their cost in value, and are now used for a purpose entirely different from the original one. They have been converted into irrigating ditches, and the

water they carry is used by farmers in cultivating their crops; and for this purpose they are becoming more valuable every year, and this increase in value will continue to grow, unless the storage system of reservoirs shall solve the question of a greater supply of water.

Nearly every farmer in Montana, except in a few locations along the margins of streams, has his own little ditch, generally constructed by himself, to carry the water to irrigate his crops. Sometimes, where a long or expensive ditch has to be built, the people along the line of it unite in the work and cost of construction and share the benefits equitably.

The ditches where the water is not sold, but used by the proprietors, either for mining or for irrigation, are not taxed separately, but are assessed as improvements on the land, like houses, barns, fences, etc.

Within the last few years, especially since the completion of railroads into and across Montana, the population has increased rapidly. The majority are farmers and they require water to irrigate their land. The wealthy capitalists have seen the necessity of supplying this great want, and knowing there is a great profit in the ownership of water have organized companies to construct ditches, take up water, and sell the same to the land-owners. If kept within reasonable limits as to the prices to be charged for water for irrigation purposes, a vast extent of country will be redeemed from a desert character to settlement and civilization and the support of a large population. But if not in a proper measure restricted in their charges, either by the State legislature or by Congress, they may become oppressive to the people.

The General Government owns the public domain, and in selling its lands to actual settlers should guaranty to each one sufficient of the water running by or through it to irrigate his farm, provided he takes it out in a reasonable time, and no one should be allowed to take it out of a stream for speculative purposes, only under such restrictions as the law may impose, where large capital is necessarily employed in constructing ditches. The water belongs to the land in this country, and much of the land is comparatively worthless without it.

The following gives a description of the large ditches which have been or are now being constructed by incorporated companies in Montana:

1. *Clarke's Fork Bottom Irrigation Ditch.*—This ditch is entirely in Yellowstone country and is 38 miles in length. It was constructed some four years ago by the Minnesota and Montana Improvement Company. It cost \$140,000 and will irrigate an area calculated at about 100,000 acres between Young's Point and Billings, on the north side of the Yellowstone River. Its width at top is 30 feet, at bottom 20 feet, and depth 3 feet.

2. *The Dearborn Irrigating Ditches.*—These canals or ditches are entirely within Lewis and Clarke County, and in course of construction by the Dearborn Canal Company, at the head of which is Donald Bradford, esq., of Helena. Arthur G. Lombard is the engineer of the company.

The head of the canal is 36 miles west of the town of Cascade on the Missouri, and the water for the several ditches is taken out of the Dearborn River.

The main canal, as far as completed, is $4\frac{1}{2}$ miles long, and discharges into Summit Lake. From this lake, acting as a reservoir, the series of ditches described hereafter will be supplied with water. The width of the main canal, at top, is 38 feet; at bottom, 20 feet. The slope of the banks is $1\frac{1}{2}$ to 1 foot; grade, 3.1 feet to the mile; current of the water, $3\frac{3}{8}$ miles per hour.

After leaving Summit Lake a portion of the water is conveyed a short distance into the head of Flat Creek, the channel of which is utilized as a canal for 22 miles, and the body of water conveyed into it will be 6 by 8 feet square.

A small lateral ditch, 2 miles in length, is taken out of the main canal at Summit Lake, and runs over to Auchard Creek, and in its course will irrigate 5,000 or 6,000 acres of land.

Another ditch, an extension of the main canal, is taken out at Summit Lake and is constructed across the country 15 miles into Sim's Creek, where it makes a fall of 75 feet, which it is intended to utilize as a water power for the propelling of the machinery of grist and saw mills for the benefit of the settlers of the surrounding country. This canal is 32 feet wide at top and 14 feet at bottom. It is calculated to irrigate 30,000 acres of land. The channel of Sim's Creek will be utilized as a ditch for 7 miles, and thence the water will be conveyed through a ditch 4 miles in length to the Little Muddy Creek, through which it will reach the Missouri River 8 miles north of the town of Cascade.

Another ditch will be constructed from the Little Muddy, 15 miles towards the city of Great Falls, to cover the bench lands on either side for that distance, and, with the aid of reservoirs at said suitable points, will irrigate about 16,000 acres of land.

When this whole system of canals and ditches is completed, with their storage reservoirs, it is calculated that it will irrigate 200,000 acres of land between the Dearborn and Sun Rivers down to the Missouri. The upper part of the canal will also be used to float logs and lumber down to the country below.

It will take several years and large sums of money to complete this great work.

The following irrigating canals, with suitable storage reservoirs, are now in course of construction by companies of Helena capitalists, among whom are Ex-Governor S. T. Hauser, A. M. Holter, Henry M. Parchen, John B. Wilson, and others, whose enterprising character and financial ability are a sufficient guaranty that they will be completed:

1. *Sun River Canal* is in Choteau and Cascade Counties—to be 75 miles long—8 miles completed; is 30 feet wide at top, 15 at bottom, and 4 feet deep; grade, $3\frac{1}{2}$ feet to the mile. Water is taken from North Fork of Sun River. Supply is abundant. When completed will irrigate 300,000 acres. Will end on high prairie, a little west of the town of Great Falls. Will cost about \$500,000.

2. *The Benton Lake Canals* are in Cascade County, 8 miles west of the town of Great Falls; are 12 feet wide at top and 6 on bottom, and $2\frac{1}{2}$ feet deep. Grade is $2\frac{1}{2}$ to 3 feet per mile. The two canals are 30 and 35 miles long, respectively. The water is taken out of Benton Lake, and will irrigate the bench lands between Great Falls and Fort Benton to the amount of 50,000 acres, and when completed will be together 65 miles long and will cost \$175,000.

3. *The Teton Canal*.—This canal is in Choteau and Cascade Counties. The water is taken from the Teton River, about 12 miles above the town of Choteau. It is 16 feet wide at top, 8 at bottom, and 3 feet deep. The canal is finished for 40 miles and is turned into a creek-bed, called the "Muddy," in which it flows for 40 miles farther, and ends about 12 miles above the town of Great Falls. The grade of the ditch is $2\frac{1}{2}$ feet to the mile. It has cost \$80,000 and will irrigate about 35,000 acres.

4. *The Florence Canal* is situated in Lewis and Clarke County, and

the water is taken out of the South Fork of Sun River, 6 miles above the town of Augusta. Ten miles are completed, and when finished it will be about 50 miles long and will run to the Little Muddy, a branch of the Missouri. Its width is 30 feet on top and 20 on the bottom; it is $3\frac{1}{2}$ feet deep, and has a grade of $2\frac{1}{2}$ feet to the mile. The 10 miles completed will irrigate 10,000 acres and it has cost about \$2,000 per mile.

5. *The Chestnut Valley Canal.*—This canal is situated in Cascade County. The water is taken out of the Missouri River at the head of the Half Breed Island Rapids, 40 miles above the town of Great Falls, on the east side of the river (as the Missouri here runs due north). It is 10 miles long; width at top 20 feet, bottom 10 feet; $2\frac{1}{2}$ feet deep; grade 2 feet to the mile. Will cost \$700 per mile and will irrigate 25,000 acres.

6. *The Gallatin Canal.*—This canal is in Gallatin County. The water is taken out of the West Gallatin and is carried 25 miles easterly across the head of Gallatin Valley and emptied into the East Gallatin, 3 miles above Bozeman. The dimensions are 40 feet wide at top, 20 at bottom, and 4 feet deep. The grade is $2\frac{1}{2}$ feet per mile. It will irrigate 50,000 acres of land. It will also be used to convey farm produce and lumber to market. It is just completed and cost \$75,000.

J. D. McIntyre is the chief engineer who has built or is now building the above-named canals, and was the engineer who organized the whole system. His brothers, H. L. and Charles, have had charge of the construction. These canals are all owned by incorporated companies, many of whose members are citizens of Helena, Mont.

The foregoing account of the construction of large water ditches shows that the people of Montana are now fully convinced of the necessity of carrying water out of the large rivers on to the bench lands and prairies at whatever cost, and that they most heartily approve of the plan of the General Government to establish storage reservoirs up in the mountains, and also to preserve the forests along the mountain sides, which have so great an influence in protecting the sources of water supply.

Nearly all the water along the small streams which can be easily and cheaply diverted into small ditches has been claimed and taken out. Hundreds of miles of such ditches are found over the Territory. Hence the necessity and importance of preserving the sources of our water supply and of constructing large and expensive canals to distribute water taken out of our large rivers.

STATEMENT OF R. L. UPSHAW, U. S. INDIAN AGENT, LAME DRER

The Indians under my charge are the Northern Cheyennes and are just emerging from their original nomadic barbarism. They know nothing whatever of irrigation except what they have observed in the past two or three years in the vicinity of the reservation. The Rosebud—a small stream about 25 feet in width and averaging 18 inches in depth—runs through the reservation. One white settler has taken out a ditch from it on the reservation, and quite a number have been taken out north of the reservation between it and its junction with the Yellowstone. Tongue River is a few miles to the east of the reservation. There are quite a number of ditches on it and its tributaries. Tongue River flows into the Yellowstone at Niles City, a place of 2,500 to 3,000 inhabitants. Niles City would probably be a point as a base from which to make observations on the systems of irrigation used upon Tongue River.

STATEMENT OF PETER RENAN, U. S. INDIAN AGENT, FLATHEAD AGENCY.

On this Indian reservation there has been a drought never before experienced. The grass crop is an assured failure, and where there are no irrigation facilities the hay and grain and vegetable crops are also certain of failure. The water in the rivers and brooks is lower than it has been ever before known at this season of the year. Where irrigation has been furnished the crops look green and luxuriant; otherwise they are crisp and burned and will be a total failure.

A few years ago I succeeded in getting an appropriation from the Interior Department to divert a small portion of the waters of the Jocko River from its main channel to a vast plateau of rich agricultural land, which, if properly irrigated and cultivated, would furnish homes for hundreds of families. The amount (about \$5,000) appropriated was entirely too small to construct a large ditch or canal, but I completed one of the following dimensions: Two feet deep, 3 feet wide in the bottom, and 4 feet wide on top. The ditch was necessarily constructed, until it reached the head of said plateau, through a rough and rocky cañon for a distance of about 2 miles, and required a good deal of fluming and blasting. The flume, like the ditch, is 3 feet in the bottom, of 2-inch plank; 2 feet high, of inch-and-a-half plank; bottom sills, 4 by 6; side pieces, 4 by 4; cap pieces, 2 by 6, all mortised and tenoned, and, like the ditch, I gave it a fall of one-quarter of an inch to the rod.

About 80,000 feet of lumber was used for the full completion of the flume and ditch, which was constructed along the foot-hills of the plateau for some 4 miles, making in all about 6 miles and covering the fields and farms of the Indian settlers in that locality. The principal work of this undertaking was done by Indians, with the exception of one or two white men who worked on the flume. The leveling, laying off, and engineering of the ditch were done by myself and a placer miner, both of us having had some experience in laying off ditches to mines in a homely way. However, it was successful, and the water runs smooth and rippling to the end. The rise from the river to the plateau was about 200 feet.

The ditch has been a source of water supply for irrigating purposes for the Indians along the line, and those who used it copiously have excellent crops this year, as well as every year since its construction. Unfortunately its capacity was too small for all who needed it, and failures in crops is the result to many farms along the line. The Indians were willing and anxious to earn wages, and the construction of the ditch furnished them profitable employment and was a means of encouragement to labor and also to keep them on the reservation and away from the whisky-drinking towns and the hunting grounds.

This ditch and flume should be greatly enlarged, as there is a never-failing and large supply of water in the Jocko River which could be turned into it all summer. There are also numerous streams and mountain lakes on this reserve which can be utilized for irrigating purposes at small expense, and the immense valleys and plateaus made to yield, without any fear of failure, good crops of all kinds of grain, vegetables, small fruits, and orchards, and to sustain thousands of human beings in one of the most lovely and picturesque countries the imagination can well conceive.

Experience and observation have shown in this country that lands upon which water can be supplied by means of ditches or canals are

capable of being reduced to the highest state of cultivation without fear of failure from a season of drought. At present the system of irrigation on this reservation is primitive; but could it be made a possibility to tap the various streams and natural mountain reservoirs, which only await the expenditure of a small amount of money to send it over the plains and plateaus freighted with the richest fertilizing materials derived from decaying vegetation and the soils of the hills and mountains, the result would be to enable the tillers of the soil to gather home at the end of every season an abundant yield of cereals, vegetables, orchards, and meadow lands.

STATEMENT OF M. P. WYMAN, U. S. INDIAN AGENT, CROW AGENCY.

The Indians of this tribe have never practiced and know nothing of the theory of irrigation, save the little instruction received from the whites employed at this agency during the past three or four years. We have but one irrigating ditch on this reserve. This ditch is about 7 miles in length and was alone completed of surveyed ditches 36 miles in extent. The cost of this ditch was about \$7,500. It irrigates several thousand acres. It requires constant repairing and most careful attention. I have in contemplation a system of ditches very extensive, but which are absolutely necessary to secure crops in the large and fertile valleys of the Big Horn, Little Horn, Pryor Creek, and the several tributaries of those streams. This matter will be fully explained to your committee on arrival here. On the irrigation of the lands held by the Crows rests solely the question of their self-support. This year there will be an almost total failure of crops. This is a source of great discouragement to the Indians, but such unfortunate events can only be prevented by proper irrigation.

STATEMENT OF C. A. OTIS, COLONEL TWENTIETH INFANTRY, U. S. ARMY, FORT ASSINIBOINE.

I have now been serving almost continuously in that section of country formerly known as the "Great American Desert" for the over period of twenty-two years. I have traversed considerable of that section between the Mississippi River and the Rocky Mountains from our northern international boundary line to the mouth of the Rio Grande.

Twenty-five years ago that portion of the same west of the 95th meridian of longitude was considered of little value for agricultural purposes because of aridity and also insufficiency or poor quality of soil, but a constantly-increasing rain-fall, apparently gradually extending westward, has demonstrated that the great plains and the valleys amid the mountain ranges need timely rains alone to cause them to produce abundantly. It is within the memory of many Minnesota citizens that to the westward of that timber belt which extends from the vicinity of Mankato to Duluth the land was parched and unproductive, and within my own experience that nothing but scanty bunch grass and cacti grew on the uplands of eastern and central Dakota where now immense fields of grain are yearly harvested.

Like agricultural growth and improvement may be seen at a good distance west of Omaha and Topeka; also conditions to produce the same results in the central portions of the Indian Territory and Texas. The soil is found to be suitable for tillage and very productive in sec-

sons of timely rains, and probably one-half, if not more, of the territory east of the Rockies would yield rich returns to the husbandman under the same conditions regarding sufficient moisture.

In the growth of crops irrigation compensates for the absence of rain. Intelligently pursued, it will cause the land of a dry climate to bring forth a greater increase than that situated within a region of ordinary rain-fall. This conclusion is based upon my slight experience and upon observation of the methods pursued by the Mormons of Idaho and Utah and by the people of Texas and Mexico. They use but little water, do not flood or deluge their land, but merely seek to create and retain the moisture needed. A diminutive stream flowing slowly along a narrow, shallow ditch serves to irrigate a large acreage as it gently and almost imperceptibly falls from the various points where the water is allowed to enter upon the fields. The land is, of course, carefully chosen with a view to systematic irrigation with the least amount of labor, and may consist of only a small fraction of a widely-extended plain—the much greater portion not answering well the purposes, although equally fertile.

By means of an extended system of irrigation a large percentage of our lands east of the Rocky Mountains now called arid might be brought under profitable cultivation, but the labor of construction and repair would be attended by a vast expenditure of money and would require many years for its accomplishment. I doubt not that it will be brought about very gradually by private enterprise, as population increases. Should the dry atmosphere of the plains and valleys of the West continue, Government aid judiciously applied to the public domain might accelerate the work, which should only be prosecuted in certain limited sections of the country at the same time. I think that the broad rich bottoms of the Yellowstone River and some of the bench lands which bound them will before many years be watered by means of large irrigating ditches constructed by private corporations, should no public assistance be extended. That stream is abundant and constant and the fall rapid. It offers numerous points from which needed water could be taken and stored. By selecting available points well up the stream it could be carried across some of the divides onto the deep fertile soil of the depressions, but agricultural industry at the present time is not sufficiently remunerative to justify so expensive a labor.

Almost the same remarks apply to the availability of the Powder, Tongue, and Big Horn Rivers. I understand that a project is now in contemplation to tap the Sun River above Fort Shaw and to carry water about 25 miles below into a large depression, formerly quite an extensive lake and a natural reservoir, from which a considerable area of land can be readily irrigated. Between the Missouri and the Maria's and the Milk River the average distance is probably 50 miles, over a length of more than 200 miles of excellent soil. The whole western half could be fed by the waters of the Upper Maria's or Cut Bank and Milk River and St. Mary's Lakes, where supply is inexhaustible, and the lower portion in all ordinary seasons by the Missouri, the tributaries of the Milk, and the streams from the small mountain systems. I have been informed that the practicability of a canal, to be supplied by the waters of the above-named lakes, following the general direction of the Milk River and entering the Missouri near the Bear Paw Mountains, has been discussed and stoutly maintained.

In a mountainous or broken country the rivers course through defiles, cañons, and along low rocky beds with sharply-defined rocky banks,

rising to an elevation of from one to five hundred feet. Frequently above such gorges the banks broaden out widely, diverging for a considerable distance, and then again approach each other, presenting well-constructed basins for the storage of water, which can be utilized by closing the gorges. At such points, if stone and clay are abundant, dams can be readily constructed and ponds or small lakes be formed. The dams can be carried to the height of the banks, if desired, by adhering to the simple rule that the breadth of base must be three times the altitude. In Spain, I believe, they have been carried four or five hundred feet high. Stone is the only material needed in the open dam, and in the close one stone and clay faced with a good layer of clay and revetted with plank. A number of such reservoirs might be constructed along any river fed by mountain streams and lakes, be filled during the spring freshets, and the water stored for use in times of drought. Ordinarily, once filled, they would receive a sufficient constant supply from the usual flow to make up for evaporation and to meet actual demands. The water from these reservoirs might be carried off to localities where it is needed by means of open ditches, or be conveyed through pipe-lines, starting from the base of the dams if necessary, so that all the water of the reservoir could be utilized. During the high water produced in spring by the melting snows the surplus could be piped from these reservoirs many miles distant to natural surface depressions and large artificial lakes be formed, from which the surrounding country could be irrigated when crops demanded it. Where there are large natural basins considerably elevated and in a naturally rolling country with rapidly falling streams, they may be supplied without the aid of dams, using open ditches or pipe-lines for feeders, and taking the water a sufficient distance up the streams to insure a good descent. From such basins the adjacent lands could be irrigated, and the labor and expense attending this method are comparatively small.

But it is in the open prairie country, through which rivers course over muddy and quicksand bottoms and are confined by loamy banks in which the currents are constantly shifting, cutting away the soil upon one bank and making extended accretions upon the other, where the spring floods inundate the lowlands and the atmosphere of summer takes up the moisture from the lands and dries up the streams, that the most difficult problem as to the best methods of irrigation presents itself. The annual supply of water, taken in its entirety, is abundant. All the important rivers flowing from the Rocky Mountain ranges furnish yearly more than sufficient water to irrigate for the growing season all the intermediate lands. Their numerous forks and tributaries are interspersed over the face of the country with marvelous regularity and offer immense possibilities. The season of freshets must, however, furnish the water needed in periods of drought, which must be gathered and stored in some manner in adequate quantities to meet the great loss resulting from evaporation and to supply demands.

In the prairie country most of the rivers have low, distant banks, and when swollen flow with rapidity over slightly and gradually descending beds. The banks are so low and unstable, and the beds so insecure, that it is difficult to place obstructions which would permanently arrest the waters or divert with system any desired portion of them. Cross dams would be undermined or washed out, and, even if they were not, the river banks are too low to permit them to be raised to any useful height. The water must be taken from the swiftly-moving surface many miles above the selected places of storage. The difficulty

in doing this consists in the nature of the banks, which, as soon as the currents should be drawn to them, would fall away and render useless contrivances to control the water. Stone walls or cribbing are worthless, unless solid foundation can be found and banks made secure.

I do not know of any contrivance or structure which would prove as effectual as the brush-wing dam projected into the river from 50 to 100 yards, forming an acute angle with the bank from which it is projected, so that the water eddying behind it would keep its level with the stream. The dam should be constructed of fascines from 12 to 16 inches in diameter and from 100 to 200 feet long, laid from three to six thick, stoutly fastened to each other, according to the volume of water and the strength of current, carried to the desired height, and securely pinned to large gabions firmly weighted, standing from 20 to 30 feet apart behind the fascines. The bank should be matted above, behind, and below the dam, to protect it against the currents and eddies; not with the Holland device, which fails on our rivers, but with fascines laid tight or with heavy brush strongly wired to firm stays or supports bedded in the earth.

This method is simple, and I believe is more likely to be attended with success than any other which has yet been tried. Our muddy rivers with quicksand bottoms can not be controlled by piles and crib-work. The Lower Rio Grande has thrown out the heaviest piles and strongest crib-work that the accomplished Mexican engineers could place and construct, but its course has been diverted, even at high water, by loose brush fastened to its banks.

This method, too, has the advantage of being economical, an important consideration, and especially so when it is remembered that these prairie water-courses are very unstable, that they sometimes cut new channels for long distances and entirely abandon the old ones, and that they continually shift their currents in their broad beds, and frequently make encroachments on one bank while they pile up the sandy loam upon the other. It will be seen, therefore, that expensive works designed to be permanent are liable to lose their value at some unexpected moment by these unnecessary caprices of the rivers and must be removed and reconstructed to be of further use.

I have spoken of the general character of these rivers. They occasionally flow through low, rocky ways, where water could be elevated by little labor and expense and made to flow out across the land; but this is exceptional. Respecting the Missouri, I do not know of a single instance of this kind below the forty-seventh parallel of latitude. The Lower Platte, the Kansas, the Arkansas, the Cimarron, the Canadian, and the Red Rivers are, I am confident, mostly without such gorges. There are numerous points where a single rocky bank is found, but it generally stands opposite extended bottom land. At these points powerful pumping apparatus might be placed, but the results to be obtained would not be satisfactory, considering the outlay involved and the expense of running, even if cheap fuel could be readily obtained.

Irrigation by means of artesian wells has been considerably discussed, but they would afford only an uncertain and, in most cases, an insufficient supply. No doubt communities and towns, as they increase in wealth and population, will experiment with them in the future as they have during the past few years, and will, if they are not located on important streams, look to them for the water which they require, but I believe that in the majority of instances these wells have been disappointing, either in the quantity or quality of water furnished. Judging

from experiments thus far made, any extended and continued irrigation of lands by these means could not be reasonably expected.

In offering these suggestions, I have been under the impression that the subject referred for remark was limited to the most practicable methods of irrigating the land contained in what has been known as the dry or desert belt, and make them suitable for agriculture, and I have not discussed character of soil or climate. I may be under some misapprehension as to the intended scope of the inquiry, and I am not informed how extended is the field which the Senate special committee has under investigation. I am, however, of the opinion that conditions are favorable for remunerative agricultural pursuits in nearly all sections of this extended territory, could systematic irrigation be established.

These lands are destined to be thickly populated. Should an increased rain-fall not attend settlement—and the experience of the past few years would lead us to hope that it will—that population will secure and store, in some way, the waters of its rivers, its rains, and melting snows in sufficient quantities to meet its demands for necessary purposes.

STATEMENT OF J. H. PATTERSON, CAPTAIN TWENTIETH INFANTRY, U. S. A., FORT MAGINNIS.

By the term arid lands I take to be meant the country lying between the one hundredth meridian, the foot-hills of the Rocky Mountains, the forty-ninth parallel, and the Rio Grande River. Though familiar with the meteorological and topographical features of western Kansas, the Indian Territory, and western Texas, I purpose confining my remarks more particularly to that portion of the country referred to which lies north of the forty-sixth parallel and within the eastern and western limits before mentioned. I have had a very much longer service in Dakota and Montana than in either of the Territories farther south.

While the topographical features of the Great Plains are very much the same throughout its vast area, the mean annual precipitation differs as the physical features of particular localities differ. In the immediate vicinity of the larger and more permanent streams, such as the Missouri, Yellowstone, Platte, Arkansas, and Canadian Rivers, the rain-fall is much greater than at points but a few miles removed from the valleys through which said streams have found their way. The physical law that storms are apt to follow the course of flowing streams is a very noticeable feature of the meteorology of the Great Plains. While, for months, at Fort Assiniboine, during the drought of 1886, we had no rain, showers were frequent in the Missouri River Valley 40 miles south.

It is characteristic of the rivers which traverse the Great Plains that they are far below the level of country which rises to the right and left of the valleys or basins through which they flow. This physical feature is particularly noticeable as to the Missouri River. The difference of level is frequently hundreds of feet for miles of its course. It is only the larger and more important streams crossing the Great Plains that can be relied upon for a continuous movement in a dry season. The Missouri River is the only one north of the fortieth parallel. In the drought of 1886, so disastrous to the agricultural and cattle interests of Montana, all streams north of the Missouri River became dry.

With the above brief and, I hope, sufficient preamble, I proceed to

the consideration of the practicability of applying irrigation to the arid lands situated within the boundaries which I have defined.

I do not think a general system of irrigation can be applied to the lands referred to, for the following reasons:

I do not think, as affecting large areas remote from the more permanent streams—Missouri, Yellowstone, Platte, Arkansas, and Canadian—a water supply can be obtained in midsummer months—when most needed—which will provide more than will suffice to irrigate the valleys to which said streams are confined. To make my meaning more clear, I desire to make a distinction between local and upland irrigation. By local irrigation I mean the irrigation of the lands located in the valleys or basins of streams; by upland irrigation, the irrigation of lands above and outside the river valleys or basins, where power must be employed to raise water to a height far above its natural level before it can be put upon the land to be irrigated.

The amount or quantity of land bordering the banks of a stream in proportion to the great body of land remote from the stream is almost infinitesimal.

The difference of level between the uplands and the stream from which the water must be taken presents an almost unsurmountable impediment to raising to the great height required the quantity of water necessary for the use intended. This physical impediment should not be overlooked. It will be found upon examination to be general.

To raise water from a stream to the high table-lands bordering its valley, resort must be had to the most powerful pumping machinery, and when done the area of land which can be irrigated will be so small in extent, as to the whole area of the arid lands tributary in drainage to the streams, as to make the effort almost valueless, as affecting the increased fertility of the section of country requiring irrigation.

It has been urged that, by a system of great tanks or reservoirs and great ditches, water can be carried for long distances. What as to the labor required to collect water upon the high table-lands in quantity sufficient to irrigate, say, 20 miles square, and what of the 50 to 100 miles of ditching necessary to distribute the water over so comparatively small an area? I doubt if there is any place on the Great Plains where water can be carried over the surface in open ditches for the distances necessary to irrigate a section of country 20 miles square; that is, where the water is supplied other than directly from a constantly running stream like the Missouri. The question is one of supply more than of flow. I doubt if sufficient water can be tanked on the upland to furnish such supply.

To cover a perfectly flat surface 1 mile square with water to the depth of 1 inch will require 13,939,200 gallons, or 2,234,466 cubic feet. The Croton Aqueduct, by which the city of New York receives its water supply, can deliver 115,000,000 gallons a day. A ditch with the capacity of the Croton Aqueduct will supply only sufficient water to cover about 8 square miles of perfectly flat country 1 inch. Question: How many tanks of the capacity of the Croton Aqueduct will be required to make any considerable increase in the fertility of the arid lands if 1 inch of water in the whole season would be sufficient?

A very large portion of the water which passes into an irrigating ditch is lost en route by absorption; therefore, while absorption by the soil it passes over is desirable, when the water is to be applied I think that its loss en route will materially diminish the amount which reaches its ultimate and intended destination. The question of loss by evaporation while en route for long distances in open ditches, exposed as it must

be to the direct rays of the sun in midsummer and the excessive dryness of the air peculiar to the climate of the Great Plains, is not an unimportant consideration in determining the practicability of upland irrigation.

I made at Fort Assiniboine, in the summer of 1886, some simple tests as to the effect of the exposure of water. A vessel containing 4 inches of water in depth, exposed for twenty-four hours to the sun and air, was entirely evaporated. I am therefore of the opinion that through the influences of absorption and evaporation it will be impossible to carry a sufficient quantity of water in open ditches for great distances except by a water way of such capacity as precludes the possibility of its construction other than by the labor of years and the expenditure of millions of money, making a new stream, as it were, to be applied as other streams to local irrigation.

That there are thousands of localities of small area along the valleys of streams where but one blade of grass now grows two can be made to grow by irrigation I do not doubt; but when such localities are found they can be reclaimed by private enterprise without going in for "the old flag and an appropriation."

I suggest the thought that, in the Northwest particularly, a variety of agricultural products is more dependent upon the mean temperature than the mean precipitation. I take my stand upon the statement that, as applied to great distances from the source of water supply, such as the Missouri, Yellowstone, Platte, Arkansas, and Canadian Rivers, any attempt to carry water by means of open ditches for great distances is entirely and hopelessly impracticable.

The dip of the Great Plains is to the east. It will be remarked that the main streams discharge their waters in the same general direction; that the smaller streams which drain the Great Plains have more of a north and south direction. This will emphasize a point I desire to present, that, as the land recedes from the larger streams to the north and south, the altitude of the land with reference to the streams from which it recedes increases; therefore the attempt to carry water by irrigating ditches in a direction other than parallel to the course of the stream from which the water supply is taken presents difficulties as to increasing height of level not easily overcome.

It will be observed that I omit mention of all mountain streams proper, which discharge their waters into the larger streams crossing the Great Plains. Local irrigation can be applied to such mountain streams without difficulty. Uplands below the level of the source of such streams can also be irrigated from them to a distance conditioned upon the water supply, and where the flow can be turned into the bank. I include all such lands among those I have mentioned as favorably located for local irrigation.

In discussing the question of the irrigation of the arid lands I have endeavored to be as concise as possible, and may have erred in that particular. I have been placed at a disadvantage in not having at hand any books of authority or reference to which I can refer. I have therefore been compelled to rely upon what some may call mere assertion, though what I have stated to be my views is the result of my conviction predicated upon observations and not a little thought and reading.

Whatever way my opinions may be received I will abide the event with watchful interest. If the proposed attempt is made, it can be done only at a most fabulous and startling expense. I believe it will fail where applied to other than local irrigation, a work which the parties interested can prosecute without Government assistance, and that every

physical law which applies to the wisdom of such an undertaking condemns it.

**STATEMENT OF P. F. HARVEY, CAPTAIN AND ASSISTANT SURGEON,
U. S. A., FORT KEOGH.**

Experience has amply demonstrated that the soil of Montana and Dakota possesses the inherent properties of fertility to such a degree that all products suitable to this climate can be produced therein in the highest degree of perfection if sufficient water is supplied to them. The plains will not yield full crops more frequently than once in five to seven seasons by natural rain-fall. There is a plentiful supply of water in the existing water courses, and the only problem that presents itself is as to how that supply shall be distributed. In my opinion and from my observation irrigating ditches afford the speediest, most efficient, and most economical means. Various systems of ditches have been used, differing with the topography and needs in each case. Usually short ditches are in vogue, covering the valleys in the immediate vicinity; but the slope of the country is so great that, by commencing near enough to the headwaters of main streams, the plateaus back of the valleys lower down the stream could readily be supplied. In my opinion the correct system, without entering into details, is the preliminary construction of dams at suitable sites and the subsequent tapping of such dams by ditches, and not by building reservoirs. The latter would be apt to be swept away by sudden deluges of rain, common all along this parallel of longitude. Dams could be built which would allow the high water to flow over them and out of the artificial channels.

**STATEMENT OF CHARLES BENTZONI, CAPTAIN TWENTY-FIFTH
INFANTRY, U. S. A., FORT SHAW.**

My experience in irrigation is rather limited, being mainly derived from my observation for a number of years of the system in use in Mexico and that part of our own country bordering on it. There the belief is that crops may be made to grow on any kind of soil if it is properly irrigated. And my experience in the Southwest, as well as here in the extreme North, where irrigation is being rapidly developed, certainly bears out these assertions. But during my ten years' service in the large tract of country embraced by the Rio Grande, Pecos, and Devil River, in Texas, between 1870-'80, I have often theoretically worked out plans for reclaiming these great stretches of arid lands. My conclusions were, and are now, that by a system of reservoirs and irrigating canals all these great plains can be brought under cultivation. By thus distributing the water and by a judicious system of arboriculture, I have no doubt the rain-fall will soon be increased; and, while I may not live to see it, the time will come when a large population will inhabit what are now nearly useless plains and valleys. Of the technical part of the subject I know too little to warrant any suggestions; but whenever I see a reference to the difficult problem of convict labor I always think that in the carrying out of such a system of improvements here under consideration all such labor could be made useful and productive without coming in competition with what is termed "free labor."

Adjourned.

ON TRAIN AT BUTTE CITY, MONT.,
August 10, 1889.

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman), Jones, and Reagan; also Director Powell.

STATEMENT OF H. M. WILSON, OF THE U. S. GEOLOGICAL SURVEY.

The CHAIRMAN. What is your occupation?

Mr. WILSON. Engineer in the U. S. Geological Survey.

The CHAIRMAN. Have you been engaged in a survey on the Sun River in Montana?

Mr. WILSON. I have been on the Upper Sun River in Montana looking for sites for storage reservoirs.

The CHAIRMAN. Will you explain, in your own way, the topography of the country, the sources of water supply, and the land to be irrigated on the Sun River?

Mr. WILSON. I prefer to begin with the land to be irrigated. I find that there is an area of bench lands, approximately 50 miles east and west and 25 miles north and south, within the boundaries of the Teton and Sun Rivers and the Rocky Mountain Range and the Missouri River, that could be irrigated if the water could be had. There the bench lands are from 400 feet to 500 feet above the river bottoms, and have a general slope from the Rockies on the west toward the Missouri on the east, which slope is roughly estimated at about 100 feet in 6 miles. The bench lands I have described, between the Teton and Sun Rivers proper, are the finest agricultural land that can be found in Montana. The soil is warm, just enough sand in it, and is sufficiently high to give good subsoil drainage. There frosts do not come so early in the fall nor are they so late in the spring as in the bottom lands, and this land, when water is applied to it anywhere, will raise from 3 to 4 tons of blue-joint hay to the acre. That is the finest hay that is raised in Montana. And the land will raise abundant crops of grain and potatoes and all kinds of vegetables. I can give you the figures: 35 to 40 bushels of wheat to the acre and 3 tons of timothy.

Estimating roughly, these sections contain about 700,000 acres of excellent land that can, most of it, be irrigated. I would not like to state that the whole of it can be irrigated until after the surveys shall have been completed. But at the present time I am inclined to think that there are 700,000 acres of fine agricultural land on those benches that can be irrigated.

West of this land, which, as I said, runs back 50 miles from the Missouri, the bench is of the same topographical character, but the soil is more rocky and I am inclined to think it is not of much agricultural value. But it is of the highest value as grazing land; and to-day it is stocked to its fullest capacity with sheep and cattle.

This grazing belt extends from 10 to 30 miles farther west to the foot of the Rocky Mountains. In the mountains rise the Sun River on the south and the Teton on the north. They have their heads at the summit of the Rocky Mountains west of this bench.

The Teton River does not carry a tenth of the permanent annual volume of water that the Sun River does, as it rests against the foot of the Rockies; but it carries a considerable volume in the spring; whereas the Sun River, having long branches through the Rockies heading around the Teton and Dearborn on the south, has a very large annual flow;

therefore its flood height is proportionately greater. At present, though, this is claimed by every one to be the driest season known in Montana since it has been inhabited, and the Sun River carries about 260 second-feet of water (meaning 260 feet of water per second), which is approximately 10,000 miner's inches. But very careful measurements of the ordinary flow of water in this river show that it probably carries some 5,000 second-feet during 25 days of flood; and it goes very much higher than that during a few days in each year, and for a number of days lower. But it is never lower than the minimum given, 260 cubic feet per second. I have roughly estimated that the annual flow of this stream is 700 second-feet.

The CHAIRMAN. That is the average through the year.

Mr. WILSON. I have roughly estimated it—it is a guess; that is, the amount of water that is in that river; and if it could be all stored during the ten months outside of the regular irrigating season it would be equivalent to 400,000 acre-feet. An acre-foot is a cubic foot of water over the surface of an acre of ground, and there are 43,000 odd acre-feet to an acre. I have not yet examined the various branches of the Sun River that head in the Rockies, but I am inclined to think their capacity might be nearly equal that of the main branch just described, making altogether a total of 800,000 acre-feet flowing there ten months, could it all be stored. But it must be remembered that a large percentage of this volume will be lost by seepage and evaporation before reaching the point at which it would be utilized.

Senator REAGAN. Are those the tributaries of the Sun River?

Mr. WILSON. My measurement was above the forks.

Senator REAGAN. That is above the tributaries?

Mr. WILSON. Yes. The estimates given heretofore of the capacity of the Sun River are the result of measurements at the cañon mouth above the main tributaries just spoken of.

The CHAIRMAN. Are the tributaries mentioned of sufficient altitude to join the main river at any point so that they can be taken on to the table land?

Mr. WILSON. I am speaking of those tributaries at the head of the mountains, starting above the land which I have given as my lowest reservoir, the one from which the main canal taking this water on to the bench will be taken. Of course, there is an immense amount of water which falls on this bench below this point. The benches are 80 miles east and west of the water, and of the water that falls on them I have not made any estimate.

The CHAIRMAN. Where you describe the water as a foot deep, is it a foot deep for once a year?

Mr. WILSON. Once a year. That is ordinarily estimated to be the amount of water necessary to be put on. Twelve inches of water added to the natural precipitation on these agricultural benches which will be irrigated is probably enough in this climate to irrigate the crops.

The CHAIRMAN. Does it not require more water to irrigate the first few years than it does afterward?

Mr. WILSON. It will require more. That has been my previous experience and observation of irrigation. My previous experience and observations have been in California, and they can reduce the amount of water necessary to irrigate a foot of land nearly one-half in three years.

The CHAIRMAN. Now, in conclusion of the whole matter, do you give it as your opinion that it is possible to irrigate the bench land which you have described from the sources of water supply you have referred to?

Mr. WILSON. I will give you that in detail now. I have shown that you have 800,000 acres of irrigable land, and that from the mountains alone can be obtained nearly 800,000 acre-feet of water annually. It now becomes necessary to describe whether that water can be stored and how much will be lost by evaporation and seepage.

I am convinced from reservoir sites that I have already described and have surveyed on the main fork of the Sun River, that all of the water on those benches can be stored. At present some of it might have to be stored on the bench near Great Falls, or what is known as Benton Lake. To reach it the amount lost by seepage and evaporation will be considerable. But I am in hopes that other reservoir sites will be found in the mountains of sufficient capacity to store the total amount of the flow of the stream. From a hasty reconnaissance of the South Fork and other forks of the Sun River, I believe that reservoir sites can be found to store all the water from those falls.

The cost of constructing the few reservoirs that I have already examined will be relatively low, ranging from \$10,000 to \$40,000 apiece, each having a storage capacity of from 500,000 to 700,000 cubic feet—a storage capacity of from 10,000 to 12,000 acre-feet apiece.

The CHAIRMAN. Will you describe some of your reservoir sites that are regarded as specimen sites?

Mr. WILSON. One of these reservoirs, which I would estimate to cost perhaps \$10,000, would be constructed where the river flows through a narrow rocky cañon 200 feet wide, above which is a flat basin capable of holding, with a dam 60 feet high, about 20,000 acre-feet of water. Because there happens to be a natural waste-weir from this dam is the reason it can be constructed at so low a figure.

The CHAIRMAN. State what you mean by a waste-weir and its purposes.

Mr. WILSON. A waste-weir is a broad channel the height of the dam, over which the flood volumes of water would be carried, thus saving the danger of its falling over the dam itself; it is a necessary and consequent expense of a dam.

The CHAIRMAN. How must a dam be constructed to allow the water to fall over it? What kind of construction would you require?

Mr. WILSON. The opinion among engineers differs very greatly.

The CHAIRMAN. We do not expect details; but state what are the general protections against undercutting.

Mr. WILSON. Dams must be constructed in the most substantial manner, of the best masonry work, and the slope down-stream side should be relatively great. The bottom of the overfall, the foot of the dam on the down-stream side, should be well paved with masonry, to save the foot of the dam from undercutting by overflow.

The CHAIRMAN. What may be substituted for that?

Mr. WILSON. You substitute a waste-weir for that.

The CHAIRMAN. How could it be constructed where you have an ample waste-weir, so that no water could flow over the dam?

Mr. WILSON. A dam of this character in a flat stream may be more cheaply constructed after having taken the necessary precautions of a puddle-bank. A dam of the character mentioned, and of a height of 60 feet, should be constructed of rock. It is not thought necessary that this should have submasonry; a core or center running the height of the dam, and made of some good clay-earth which would be impervious to the passage of water, should be constructed with the dam.

The CHAIRMAN. Running up in the center of the dam?

Mr. WILSON. The dam built up with a wall through the center. It might be masonry. I am considering in this case that the puddle might be sufficiently good if you had a dam only 60 feet high. I have not looked into the matter sufficiently to know, and before making such a statement I would like to go into the calculations to know whether it would stand it. I am stating my impressions. The loose rock necessary to construct the bulk of the dam can be blasted out of the sides of the cañon adjacent to its abutments, and the canal from the lowest of these reservoirs can be constructed in the cheapest manner through earth, and will be $8\frac{1}{2}$ miles long to reach the summit of the bench between the Teton and Sun Rivers, when it can be carried upon the entire area described as irrigable land. Such a canal, to carry 800 second-feet of water, would not cost over from \$3,000 to \$5,000 a mile. Should it be found that all this water can not be stored in reservoirs on the river just described, the surplus can be carried into what is known as Benton Lake, situated on the summit of the bench 8 miles west of Great Falls. This lake is all drained by a gate, which has been constructed by private parties at a cost of \$1,000. It can be made to store the water of a given area of 40 square miles to an average depth of 20 feet, and probably with a capacity of 400,000 acre-feet.

The CHAIRMAN. In addition to this—outside of the works that you have described—have you noticed in this vicinity, or in other vicinities which you have examined, small streams and ravines that sink in the valleys, where there are opportunities for making small storage works to bring the land in their basins under cultivation?

Mr. WILSON. I have made a list of twenty-five such.

The CHAIRMAN. In this vicinity?

Mr. WILSON. In other parts, within a hundred miles of that neighborhood and 100 miles south of Great Falls—between there and Livingstone. Each of these twenty-five will store from 10,000 to 30,000 acre-feet of water, and each, I am inclined to think, can be filled. I think that sufficient water will be found to fill them.

The CHAIRMAN. If that should be the case, that will bring under cultivation how much land?

Mr. WILSON. All that is good agricultural land below. They would reclaim 15,000 acres apiece.

The CHAIRMAN. And there are twenty-five of them?

Mr. WILSON. Yes; I give it from 10,000 to 20,000 acre-feet.

The CHAIRMAN. The expense of doing that would be very great.

Mr. WILSON. Not very great. It is, relatively speaking, extremely small. This can be done only in a great way.

I wish to make a remark on another point. Private parties in the Territory of Montana, where they expected to make 200 per cent. per annum on their money, concluded that they could reap a good harvest by constructing works themselves without Government aid of any kind. Such works have been constructed on Dearborn River, and I wish to explain to your committee that such works are being constructed by the Sun River Canal Company and the Benton Lake Company, and I have no doubt that ultimately private parties will construct all these works and make good profits.

Adjourned.

MISSOULA, MONT., *August 11, 1889.*

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), Jones, and Reagan; also Director Powell.

STATEMENT OF FRANK H. WILLIAMS, OF MISSOULA

The CHAIRMAN. How long have you resided in Missoula?

Mr. WILLIAMS. Thirty-odd years.

The CHAIRMAN. What is your occupation?

Mr. WILLIAMS. Attorney at law.

The CHAIRMAN. We would like to have you explain the situation in this country.

Mr. WILLIAMS. In reference to Bitter Root Valley proper, which is some 60 or 70 miles in length and varying in width from 4 to 12 miles, I would like to say that there is in that part at the present time sixteen townships, and two-thirds of the land in those sixteen townships is surveyed. Probably one-half of the surveyed portions of these sixteen townships has been entered under the various land laws of the United States, with probably not more than one-fourth of this entered land under cultivation. But the entire area of land in that valley under cultivation is cultivated by means of irrigation.

The CHAIRMAN. About how many acres would that be?

Mr. WILLIAMS. It would be almost impossible to form an estimate of how much land that would be without getting at some data.

The CHAIRMAN. Equal to one entire township?

Mr. WILLIAMS. Oh, yes; it is equal to four townships.

The CHAIRMAN. That is actually under cultivation?

Mr. WILLIAMS. There are four townships under cultivation. These lands are irrigated from lateral streams putting into the Bitter Root River, and four or five ditches which are now constructed from the Bitter Root River. A portion of the land is waste land, rocky and broken; but there is an area of land on the east of the valley-upper bench land, we term it, agricultural land, but entirely worthless at the present time for the reason that there is no water.

The CHAIRMAN. What is the area of that land?

Mr. WILLIAMS. Three or four townships. Taking it from the stream called Woodchuck to the upper end of the valley there are probably six townships. It is good land, but it lies too high to get water onto it without going to great expense.

Now, in Bitter Root Valley, if a ditch were taken out there some 10 or 12 miles in length it would cover this land. Some parties were there two or three years ago looking at it with a view to taking out a ditch, but the matter fell through. This land that is not now cultivated for the want of water is some of the best land in that section of the country. The warmest and most productive land in this section of country is on these foot-hills—this bench land. The Bitter Root River furnishes a large supply of water, and there is enough to irrigate the entire valley and leave water in the spring.

The CHAIRMAN. Are there any valleys on the branches of the Bitter Root above here?

Mr. WILLIAMS. Yes, a few valleys; but where there are small valleys on the streams tributary to the Bitter Root, they do not get enough water out of the streams for the irrigation of the land lying on each side of the stream for some distance. But the land lying back from

the streams and upon the benches is destitute of water and is now vacant.

The CHAIRMAN. Is there much land of that character?

Mr. WILLIAMS. There is considerable land of that character.

The CHAIRMAN. Have you ever considered the practicability of storing water and irrigating the land on the benches?

Mr. WILLIAMS. I have to some extent, but I reckon that would depend upon the topography of the country. There are some cañons in these mountains, but they are abrupt, and it would be difficult to get places to store water. But there are some places where, if proper reservoirs were built, if dams were built across them during the high season of water, you could get enough to last throughout the entire season.

The CHAIRMAN. Have you been higher up on those streams where they head to ascertain whether or not they head in flats and basins?

Mr. WILLIAMS. I have not been on those streams myself; but I have seen persons who have been, and they say there are a number of streams lateral to the Bitter Root River; and I know from observation of those mountain lakes that if there were some protection in the way of embankments built across their outlet they would form very large reservoirs. I have an instance in my mind in Deer Lodge County. There is a lake there, and for purposes of mining they built a dam across the mouth of it, and they got a large amount of water which they use during mining seasons.

The CHAIRMAN. Without going into detail, from what you have seen state whether you would think it would be useful to have the tablelands of this country on both sides of the valley surveyed with a view to ascertaining whether there was an opportunity of getting water on to them, the cost of doing that at different points, and to have them mapped and pointed out.

Mr. WILLIAMS. I think so.

The CHAIRMAN. Do you think there would be opportunities for individuals to combine to make farms if they knew what the country contained?

Mr. WILLIAMS. I do not think there is any question of it. This tract of land that I speak of on the east side of the Bitter Root Valley is lying vacant because individuals can not take the water up to it.

The CHAIRMAN. How much would it cost to take the water up there?

Mr. WILLIAMS. That is something I do not know anything about.

The CHAIRMAN. How many miles long would the ditch have to be?

Mr. WILLIAMS. If you took the water from the river the ditch would have to be 10 or 12 miles at least.

The CHAIRMAN. How many acres would it cover?

Mr. WILLIAMS. Five or six townships, and of the very best land in the valley.

The CHAIRMAN. In six townships you would have considerably over 100,000 acres. Now, you say you could get water to that land by constructing a ditch 10 or 12 miles long?

Mr. WILLIAMS. I think from 12 to 15 miles—you might put it at 15 miles.

The CHAIRMAN. If you could put water onto that land for \$200,000 it would be cheap, would it not?

Mr. WILLIAMS. I think so.

The CHAIRMAN. What is the land which is under cultivation worth there?

Mr. WILLIAMS. It is worth from \$10 to \$15 an acre.

The CHAIRMAN. Is this other land that you speak of good if it had water on it?

Mr. WILLIAMS. It is equally good.

The CHAIRMAN. Would an average of \$20 an acre be about fair?

Mr. WILLIAMS. I do not think it would be too high if there was sufficient water to irrigate both.

The CHAIRMAN. If this land were surveyed so that you could know what to do, are there opportunities where a few men could combine to store water, or could a single individual store water enough to irrigate 50, 100, or 500 acres of land on these benches?

Mr. WILLIAMS. I do not think there are, because all the water supplies are appropriated.

The CHAIRMAN. Is there any water stored here?

Mr. WILLIAMS. No.

The CHAIRMAN. What proportion of water runs to waste, taking the year round?

Mr. WILLIAMS. From the middle of May until the 1st of July, while the snows are melting, there is probably four-fifths of it goes to waste.

The CHAIRMAN. You irrigate here pretty early, do you not?

Mr. WILLIAMS. Yes.

The CHAIRMAN. Are there many small streams from which you could irrigate your farms at the right time if you had stored all the water that comes down them?

Mr. WILLIAMS. Of course there are streams 4 miles west of here in which, during ordinary years from the middle of May until the 1st of July, there is a great body of water which goes to waste. After that time there is only enough to irrigate a limited number of farms. If the water that goes to waste down those streams from the 1st of May could be stored, so that it could be used, it would irrigate a large amount of land that is now idle. And there are fifteen farms that could be irrigated by this creek that are idle to-day because there is no water. We have the water and the land, but we can not get them together.

The CHAIRMAN. If you have water-sheds and land to be irrigated, nature has provided some way to save the water so that you can get it upon the land. Do you think surveys to ascertain what may be done would be useful?

Mr. WILLIAMS. Yes. As I stated before, if reservoirs were built on those streams to catch the water from the melting snow and store it up until late in the season there would be an abundance of water to irrigate the land.

The CHAIRMAN. What is your irrigating season?

Mr. WILLIAMS. From the 1st of May until the middle of July. Of course meadow land they irrigate earlier.

The CHAIRMAN. What is the effect of irrigation in the way of producing crops in this country where irrigation has been practiced?

Mr. WILLIAMS. Irrigation depends entirely upon where we can get the water. With it we produce the finest kinds of crops, and without it nothing at all.

The CHAIRMAN. You can not farm without irrigation?

Mr. WILLIAMS. Except on a few lowlands. The great bulk of our land would be worthless for agriculture without irrigation.

The CHAIRMAN. On the lowlands where there is moisture from seepage you can raise some crops; but there is not sufficient rain-fall at the time the crops are matured to produce good crops.

Mr. WILLIAMS. We have a rain-fall in the spring; but to do away with irrigation there is not enough rain-fall. The rain that falls soon

dries out, and if we have not enough water with which to irrigate the crops dry out.

The CHAIRMAN. What would be good crops of barley, oats, and wheat in this country?

Mr. WILLIAMS. I do not know much about barley, but oats here will range from 50 to 70 bushels to the acre, and the wheat will run as high as 50 to 60 bushels and down to 25 and 30 bushels.

STATEMENT OF W. J. STEPHENS, OF MISSOULA.

The CHAIRMAN. How long have you resided in the town of Missoula?

Mr. STEPHENS. Since 1870.

The CHAIRMAN. Has your attention been called to the subject of irrigation?

Mr. STEPHENS. It has.

The CHAIRMAN. State any facts you think would be of interest to the committee.

Mr. STEPHENS. I will state a few facts. In my opinion what we need most is something to start with, perhaps private capital, in storing the water, and to do that a knowledge of the water-sheds of the country is absolutely necessary. But men who have the means do not like to spend their money for the purpose of investigating. But if there were a method devised for storing the water, these business men might use their capital. Hence, if we were aided by a survey, so that the people would know the true condition of our mountains, private capital might take hold of this enterprise, and we could have the water stored without the aid of the Government.

There is another thing. On what we call the west side of the range of mountains most of our streams head in lakes. I venture to say that if you will follow the heads of our streams you will find they merge into swamps, and then form into lakes in the mountains. These lakes invariably have an outlet. This outlet passes under ground, the water seeps away under ground, and does not flow away on the surface to enlarge our rivers. This water which goes under ground would have to be raised somewhat, and if these lakes were investigated and it were ascertained how this water that percolates under ground could be got onto the surface, we could store that water, and could even run it into our streams and use it by ditches. Take this stream, the Rattlesnake, which flows right down here by this town. That creek flows off about four-fifths of the natural water-shed, and no person has attempted to store it, because there has not been a sufficient investigation of the condition of things above. From, say, May, June, and July, that stream runs as a torrent and passes off.

The CHAIRMAN. Do you know anybody who has been up that stream and explored its source? Have you ever done so?

Mr. STEPHENS. I have not been up except for some little distance. There are some persons who have been up it.

As illustrating this matter, I will say that I am part owner of a mining ditch in Deer Lodge County. We sought to build a reservoir above that ditch, and we put a dam in front that would run the water back a mile. But we were under a lake, and the great difficulty with us was this: We wanted the water from that lake, and we thought if we could get the water of that lake so that it would not percolate through the ground under our ditch we could save it. But it would percolate through the ground.

STATEMENT OF CHARLES WINTER, OF MISSOULA.

The CHAIRMAN. What is your occupation?

Mr. WINTER. I am a farmer.

The CHAIRMAN. Where do you farm?

Mr. WINTER. Three miles out of Missoula.

The CHAIRMAN. How long have you been farming?

Mr. WINTER. About three years.

The CHAIRMAN. What was your occupation before that?

Mr. WINTER. I dug ditches for different farmers and have worked in the mines in different places.

The CHAIRMAN. Are you familiar with the country on each side of the river far back?

Mr. WINTER. I am.

The CHAIRMAN. Have you traced any of these streams that are tributary to the Bitter Root?

Mr. WINTER. Yes; a great many of these streams.

The CHAIRMAN. To their sources?

Mr. WINTER. Yes.

The CHAIRMAN. What opportunities have you found above where dams could be constructed for storing water?

Mr. WINTER. After you get to the heads of these streams they flatten out. The heads are on the summit of the mountains, and there would be no place there for a reservoir. The summit of the mountains are flat and the soil there is boggy, and they are small places.

The CHAIRMAN. And the snow falls very deep there?

Mr. WINTER. The snow falls very deep.

The CHAIRMAN. And lies there a considerable time?

Mr. WINTER. Until June or July.

The CHAIRMAN. If you made reservoirs there, there would not be much evaporation?

Mr. WINTER. The summits are flat and level, and they would overflow.

The CHAIRMAN. Did you ever see places selected by mining men for reservoirs? Do you know they often select the top of a knoll?

Mr. WINTER. Sometimes high up, but generally they are down in a gulch.

The CHAIRMAN. A ravine is not a good place for a reservoir, is it?

Mr. WINTER. No. That is the trouble with these places. You must go on the mountains.

The CHAIRMAN. Why not go on the mountains at first and get less evaporation. If you can store water there it is just as good?

Mr. WINTER. But you would lose a good deal of that water. It would seep and run below. It comes out several hundred feet below, in the cañons.

The CHAIRMAN. There are places up there to store the water?

Mr. WINTER. There are places there; but you could not do it without considerable waste.

The CHAIRMAN. Some would waste, perhaps.

Mr. WINTER. A good deal would waste.

The CHAIRMAN. How many streams have you traced up to their source?

Mr. WINTER. The Rattlesnake and Grand Creek.

The CHAIRMAN. What did you find at the head of Grand Creek?

Mr. WINTER. A lake.

The CHAIRMAN. How much of a lake?

Mr. WINTER. A mile and a half wide, and probably a mile and a half long.

The CHAIRMAN. Has that much of a water-shed?

Mr. WINTER. There are mountains on both sides.

The CHAIRMAN. How deep is the lake?

Mr. WINTER. That I do not know.

The CHAIRMAN. Is it a deep lake?

Mr. WINTER. It appears that way.

The CHAIRMAN. Suppose you were to put down a tunnel into it to draw the water up and then construct a dam with gates, would that furnish water at the right time for irrigating?

Mr. WINTER. I should think it would at the proper time. I do not know that it would drain dry.

The CHAIRMAN. It has a water-shed and some water could get into it.

Mr. WINTER. Some water would get into it; but it would overflow into this creek.

The CHAIRMAN. But you would stop the overflow by damming it?

Mr. WINTER. Yes.

The CHAIRMAN. But no one has done it?

Mr. WINTER. There is no one in my country to do it.

The CHAIRMAN. Have you ever estimated the cost, to be able to say how much a man must be worth to do something of that kind?

Mr. WINTER. I have not. I have done some of it myself, on a small scale.

The CHAIRMAN. Have you ever been up the streams on the other side?

Mr. WINTER. No; not much.

The CHAIRMAN. How much water at one time would it take to irrigate the land here—10 inches or a foot?

Mr. WINTER. I should say 300 or 400 inches of water.

The CHAIRMAN. To what depth would you put it on?

Mr. WINTER. If we leave the water on one night that would be enough.

The CHAIRMAN. That is, once a year?

Mr. WINTER. Twice a year.

The CHAIRMAN. Six inches would do that—1 inch, 2 inches; so long as the ground is covered would be sufficient. You calculate by miner's inches?

Mr. WINTER. We do, generally.

The CHAIRMAN. How many miner's inches for an acre?

Mr. WINTER. I should think 20 miner's inches would cover an acre of ground in a night—10 miner's inches would.

The CHAIRMAN. I do not mean for a night, but for a year. How many miner's inches would you want for a year?

Mr. WINTER. Four hundred inches would irrigate 160 acres of ground for a year. But that would irrigate several farms.

The CHAIRMAN. In California they calculate that it will take a miner's inch to irrigate an acre, and they can have as many acres of land under cultivation as they have miner's inches of water. They have gone on and have found by economizing the water, putting it on the land at the proper time, as in San Diego County, that they could do with less—a tenth even.

Mr. WINTER. We always calculate 1 inch. What I am speaking of is the 400 inches to 160 acres. Ten farms could use that water. I would use it one week and my neighbor the next.

The CHAIRMAN. That would be 1,600 acres, would it not?

Mr. WINTER. Yes.

The CHAIRMAN. And that would be a fourth of a miner's inch to the acre?

Mr. WINTER. I probably put that too low. They cut it down one-tenth. A small stream of water has no effect; it does not spread. It takes at least 300 or 400 inches of water to spread over that body of land. Then I would give it up and another ranch would take it.

The CHAIRMAN. What do you raise on your farm?

Mr. WINTER. Wheat and oats.

The CHAIRMAN. What is a good crop of oats?

Mr. WINTER. From 50 to 75 bushels.

The CHAIRMAN. Is that regarded as an average good crop?

Mr. WINTER. Yes.

The CHAIRMAN. How about wheat?

Mr. WINTER. Twenty-five to fifty bushels—sometimes 60 bushels. But the average crop of wheat is 40 bushels to the acre.

The CHAIRMAN. Do you raise potatoes?

Mr. WINTER. Yes.

The CHAIRMAN. How many potatoes will an acre produce?

Mr. WINTER. Five hundred bushels.

The CHAIRMAN. Have you ever known that to be done?

Mr. WINTER. Yes; I raised that many myself last year.

The CHAIRMAN. What do you say in regard to fruits?

Mr. WINTER. Some fruits are good. Apples grow well. Berries also do well—such as gooseberries and currants.

The CHAIRMAN. How about plums?

Mr. WINTER. They do well.

The CHAIRMAN. How with regard to pears?

Mr. WINTER. I do not know anything about pears. We have not had much experience with pears. But there are some gentlemen here who have orchards who can explain.

The CHAIRMAN. You raise almost everything here?

Mr. WINTER. Yes.

STATEMENT OF E. BRYANT, OF STEVENSVILLE.

The CHAIRMAN. How far is Stevensville from here?

Mr. BRYANT. Twenty-six miles.

The CHAIRMAN. What are the general boundaries of this county?

Mr. BRYANT. I believe it is bounded by mountain tops, so far as I know.

I wish to speak for a class of poor men. I represent that class of men. Though we have not as much brains as we ought to have, and no money at all, some of us do a good many hard day's work. I live in a vicinity where there are, perhaps, twenty ranches that are entirely out of water this year, and none of us are raising anything at all. Realizing the necessity of water I individually made a survey from our neighborhood up to the Bitter Root River, and found that it would take a ditch at least 22 miles long, and then it could be continued 22 miles further down to where it would then accommodate fifty farms.

The CHAIRMAN. Containing how many acres of land?

Mr. BRYANT. I could not tell the number of acres. Most of them there would have 160 acres.

As I was surveying, some of the men came to me and said they wanted 160 inches of that ditch when the ditch was built. That ditch would be

20 feet wide, starting out of the river, and 3 feet deep, which would take nearly all the water in the river, and it would be all used by the ranches.

The CHAIRMAN. Did you estimate the cost of construction of that ditch?

Mr. BRYANT. I think that ditch running 22 miles that I surveyed to accommodate the fifty men would cost not less than \$40,000. We are poor men. We can furnish the muscle, but not the money. It has been estimated that if we could have had this ditch this year so that we could use the water it would have paid for itself. I got together a lot of the boys at one time, and none of us had \$100. Yet we constructed a ditch 22 miles long on the side of the mountains. I surveyed it with a triangle, and the water is running in that ditch to-day. We constructed it by going to work ourselves. Part of us would go to work outside to get supplies, and the balance would work on the ditch. We all did that. But we constructed another ditch that cost \$1,500, and we have not the water yet; some other men got the water.

The CHAIRMAN. Have you ever examined that creek to see whether you could store water in lakes above so that you could all get some of it?

Mr. BRYANT. I have not examined to see; I have only guessed at it.

The CHAIRMAN. Have any of the farmers here, when they have a small amount of water, attempted to ascertain whether they could open lakes and increase the water supply?

Mr. BRYANT. I think the general opinion is that if we could get water out of these rivers it would be sufficient, that is, for present wants.

The CHAIRMAN. You say the ditch for which you made a survey would take out all the water.

Mr. BRYANT. It would now, because the water is extremely low.

The CHAIRMAN. Then there would have to be water stored in order to irrigate the whole of this valley.

Mr. BRYANT. There could be enough stored.

The CHAIRMAN. Could there have been enough saved this year to irrigate the valleys on each side, not taking into consideration the benches?

Mr. BRYANT. It would irrigate the lowlands, but not the benches.

The CHAIRMAN. What percentage of this water goes to waste?

Mr. BRYANT. Four-fifths of it.

The CHAIRMAN. Do you utilize one-fifth?

Mr. BRYANT. I think there are ditches that would take one-fifth.

The CHAIRMAN. So that if you had this four-fifths you could extend the area of land which would be under cultivation?

Mr. BRYANT. Yes.

The CHAIRMAN. You are a surveyor?

Mr. BRYANT. I survey by a triangle.

The CHAIRMAN. With what examination you have made, are you able to say whether or not a thorough survey of this region showing the water supply and the land to be covered and the cost of reservoirs, ditches, etc., would be beneficial?

Mr. BRYANT. I think it would be.

The CHAIRMAN. There have been two appropriations made for that purpose, and I wish you to say whether or not you think it would be of sufficient advantage to warrant the Government in going ahead with the surveys.

Mr. BRYANT. Yes. To illustrate: Take this ditch that I surveyed. If we could have had this ditch this year so that we could have used the water it would have paid for itself, and the probability is that further developments could be made with like results.

Director POWELL. You live in the Bitterroot Valley?

Mr. BRYANT. Yes; 26 miles up.

Director POWELL. Most of the small streams go down on the other side of the river?

Mr. BRYANT. Yes.

Director POWELL. Are there farming lands on this side?

Mr. BRYANT. Yes.

Director POWELL. They are taking up the small streams on the other side of the river?

Mr. BRYANT. Yes.

Director POWELL. But they do not take out from the big stream?

Mr. BRYANT. No; not on the other side. They use all the small streams on the other side, but they would use much more on this side if they could.

Director POWELL. All the irrigation on the other side is in the same way.

Mr. BRYANT. Yes.

Director POWELL. But the great enterprise of taking out the Bitterroot River has not been entered upon to any extent?

Mr. BRYANT. No.

Director POWELL. Are there many small streams on this side?

Mr. BRYANT. Not on this side. There is not a small stream on this side of the river that is putting in a particle of water at the present time. From here 60 miles up it is all taken out and there would be twice or three times as much used if they could get it.

The CHAIRMAN. How far down is it before this river joins the Clarke River?

Director POWELL. From the mouth of this stream below where the Bitterroot comes in it is called Missonla. Right here it is Hell Gate, and it is all the Bitterroot. [Addressing Mr. Bryant.] Are all those big streams on both sides used to-day?

Mr. BRYANT. Not a fourth of the waters on the west side of the Bitterroot are used, but nearly all on the east side, as we call it here. There are three or four ditches taken out 12 feet wide and 2 feet deep where they come out of the river, and they supply the upper part of the valley. Yet if we had several more such ditches they would all be utilized. Much of the land that is now lying vacant would be taken up if the water from the river could be gotten on to it. And if the Government is going to help us at all, it can help us to get ditches out of the stream. Reservoirs may do after a while, but we want the water immediately.

Director POWELL. You have computed the cost ordinarily of taking out these small streams. How much does it cost per acre to get the water?

Mr. BRYANT. It has cost us heretofore nearly \$4 for an inch of water, a miner's inch. That, judiciously applied, would irrigate nearly 40 acres.

Director POWELL. So that to take the water from these small streams it costs you from \$1 to \$1.25 an acre.

Mr. BRYANT. Yes. I only speak of one ditch—some cost more and some less.

Director POWELL. Do you know anything about the Fork up here?

Mr. BRYANT. Yes.

Director POWELL. How much of the water in that goes to waste?

Mr. BRYANT. Not any. There is not enough of it.

Director POWELL. Do you know anything about the head of that stream—the source of it?

Mr. BRYANT. I have never been to the head of that creek. I have been up it some 20 miles, but never to the head.

Director POWELL. It comes out to a cañon?

Mr. BRYANT. Yes. Not all the water, perhaps three-fourths of it, goes to waste; but ordinarily it is all used.

The CHAIRMAN. What is running at the time you want to irrigate is all used?

Mr. BRYANT. Yes. This season there has not been any going up the river.

Director POWELL. Have you any lost rivers in this country?

Mr. BRYANT. No. You mean waters that have sunk into a bed and gone out of sight?

STATEMENT OF E. W. BERRY, OF MISSOULA.

The CHAIRMAN. How long have you resided in Missoula?

Mr. BERRY. It is about 24 years since I came here.

The CHAIRMAN. What is your occupation?

Mr. BERRY. I do most everything. I am county assessor now. I have been farming in the county. I have raised sixteen crops here.

The CHAIRMAN. What is the extent of your county? Can you bound it?

Mr. BERRY. It runs from the Beaverhead, on the south, to the British line, about 225 miles—about 300 miles north and south.

The CHAIRMAN. How much east and west?

Mr. BERRY. Somewhere about 200 miles.

The CHAIRMAN. There is an Indian reservation in this county, I believe?

Mr. BERRY. Yes; the Flathead.

The CHAIRMAN. In assessing, have you traveled over the county pretty generally?

Mr. BERRY. Yes; three times I have been over the county.

The CHAIRMAN. What is the character of the crops produced in the county by irrigation? In the first place state what kinds of crops you raise.

Mr. BERRY. Wheat, oats, barley, potatoes, all kinds of garden truck.

The CHAIRMAN. And fruit?

Mr. BERRY. And fruit.

The CHAIRMAN. What is a good crop of potatoes?

Mr. BERRY. It depends on the character of the land. I have seen 800 bushels to the acre and from that down to 50 right in Flathead last year. I weighed the potatoes myself.

The CHAIRMAN. What would be an average crop on good land?

Mr. BERRY. I suppose it would be 300 bushels.

The CHAIRMAN. What is an average crop of wheat?

Mr. BERRY. About 50 or 60 bushels—well, from 40 bushels up; and some land does not produce 15 or 20.

The CHAIRMAN. What would be an average crop—a general crop?

Mr. BERRY. Perhaps 30 bushels.

The CHAIRMAN. How much of oats?

Mr. BERRY. From 40 to 60 bushels.

The CHAIRMAN. You say you have been farming yourself?

Mr. BERRY. Yes.

The CHAIRMAN. What is the expense of irrigating land after you get the water on it? Is it more expensive to farm land by irrigation than it is in countries where you do not irrigate?

Mr. BERRY. Why, certainly it is. You have to put in your time irrigating, and that costs something.

The CHAIRMAN. How is it as to the certainty of crops?

Mr. BERRY. Without irrigation?

The CHAIRMAN. With irrigation.

Mr. BERRY. There is nothing here without irrigation.

The CHAIRMAN. Are you always sure then of a crop?

Mr. BERRY. Yes.

The CHAIRMAN. Have you ever known a failure in this valley where they had water to irrigate?

Mr. BERRY. No, unless the grasshoppers come.

The CHAIRMAN. Have they come often?

Mr. BERRY. No, not very often.

The CHAIRMAN. They have been here how many times since you have been here?

Mr. BERRY. I think three times. They were here somewhere about 1865.

The CHAIRMAN. Barring grasshoppers, there is no failure of crops where you irrigate properly?

Mr. BERRY. No.

The CHAIRMAN. In traveling over the county have you had your attention called to the water supply for irrigating the land?

Mr. BERRY. Oh, yes.

The CHAIRMAN. What proportion of land in this county is fit for irrigation?

Mr. BERRY. That is fit for cultivation?

The CHAIRMAN. For irrigation.

Mr. BERRY. Oh, I should think—I do not know that I understand you.

The CHAIRMAN. How much would be good land if it were irrigated—had water on it?

Mr. BERRY. Take any particular portion, leaving out the mountains.

The CHAIRMAN. I mean the whole county. Taking all the land in the county, what proportion of it, if irrigated, would be fit for cultivation? Of course you will have to make an estimate.

Mr. BERRY. That I can not do. The Bitterroot Valley is about 60 miles long.

The CHAIRMAN. You need not go into details. If you have not considered the matter so as to give the result you need not estimate. How is the water? Is there a sufficient supply to irrigate the land, taking the benches and all?

Mr. BERRY. Yes, if it were used.

The CHAIRMAN. Some of the land lies too high, I suppose, to get the river onto it at a reasonable expense. Are there not mountain valleys, elevated valleys, plateaus, benches?

Mr. BERRY. No, not much of that kind of land. The Bitter Root River could be brought around to irrigate all until you get around to the steep side of the mountains, and there is sufficient water on the west side in the way of streams to irrigate that.

Director POWELL. If they could use all the small streams on the west side of the Bitter Root River they could irrigate all the land on that side?

Mr. BERRY. Yes.

Director POWELL. And then the main stream could be utilized on this side?

Mr. BERRY. Yes.

Director POWELL. You think enough water could be gotten to irrigate it all if it were taken out aright?

Mr. BERRY. Yes, if it were stored.

The CHAIRMAN. What is the opportunity for storing the water in this county and increasing the flow if necessary?

Mr. BERRY. At the head of the valley there is a good chance for a reservoir. There is a valley up north, 150 miles from here, where I have been living for the last few years, which is 30 miles square and which has very rich soil. We have raised crops there without irrigation—very little of it is irrigated. The Flathead River runs right through it, and heads in the British possessions and ends in a lake. There is where the university lands are.

The CHAIRMAN. Is there plenty of water there to irrigate with?

Mr. BERRY. Plenty, if it were utilized.

The CHAIRMAN. Is there any difficulty in doing that?

Mr. BERRY. No, only want of money. Two creeks that come in from back in the mountains sink before they get to the valley. They are called lost creeks.

Adjourned.

EASTERN WASHINGTON DIVISION.

MOXIE COMPANY'S RANCH,
Yakima, Wash., August 13, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), Jones and Reagan; also Director Powell.

STATEMENT OF JAMES M. HALL, OF YAKIMA.

The CHAIRMAN. What is your profession or occupation?

Mr. HALL. Civil engineer.

The CHAIRMAN. Have you ever been engaged in surveying for purposes of irrigation?

Mr. HALL. Yes.

The CHAIRMAN. Where?

Mr. HALL. In California and in Washington Territory.

The CHAIRMAN. Are you acquainted with the Moxie Company's ranch?

Mr. HALL. Yes.

The CHAIRMAN. Are you acting as engineer for that company?

Mr. HALL. Yes.

The CHAIRMAN. How long have you been engaged in engineering for that company?

Mr. HALL. About two years and a half.

The CHAIRMAN. By what means do they irrigate their farm?

Mr. HALL. By means of a canal taken out of the Yakima River.

The CHAIRMAN. About how much land is below the canal that may be irrigated by it?

Mr. HALL. That I can not say off-hand; about 6 or 7 sections—4,000 or 5,000 acres.

The CHAIRMAN. How is it as to the water in the Yakima River? Is there an abundance of it?

Mr. HALL. Yes; there is plenty of water for our purposes.

Senator JONES. What proportion of the water do you take out of the river where this ditch comes?

Mr. HALL. That I can not state, because we have not made any cross-section of the river.

Senator JONES. Could you approximate it?

Mr. HALL. I would not like to do so without a survey. We do not take one-twentieth, probably not one-fortieth.

The CHAIRMAN. What is the character of the land that you irrigate here—what kind of soil?

Mr. HALL. It is an ashy loam. The lower bench is a finer soil than the upper. The upper is more coarse—more sand in the upper bench.

The CHAIRMAN. Have you a subsoil which is different from the surface soil?

Mr. HALL. That I could hardly answer.

The CHAIRMAN. There is no underlying strata that holds the water?

Mr. HALL. No, not immediately near the surface.

The CHAIRMAN. State how you irrigate where the soil is coarse sand and gravel.

Mr. HALL. We have no land of that description under water at present; that is, to amount to anything.

The CHAIRMAN. How could that be irrigated in this valley?

Mr. HALL. That could be irrigated in different ways.

The CHAIRMAN. What would be the best way to irrigate that land?

Mr. HALL. It would depend on what you would plant. If it were grain, I should flood it; if it were trees or anything planted in rows, I should say run the water through rows—plow through in furrows. And that would depend on the nature of the soil. As to furrows, if it were gravelly and sandy, those ditches would be wider.

The CHAIRMAN. Then, as I understand you, if the soil is loose, so that the water will percolate, you may have your ditches or furrows farther apart?

Mr. HALL. Yes.

The CHAIRMAN. And the water will percolate from one to the other?

Mr. HALL. Yes.

The CHAIRMAN. Have you seen any sandy soil with a clay subsoil?

Mr. HALL. No; I have not seen that.

The CHAIRMAN. There is none of that kind here?

Mr. HALL. No.

The CHAIRMAN. Explain the mode of irrigation where the soil is closer.

Mr. HALL. Understand me. Here on the ranch, on the same nature of soil, we irrigate differently different crops. For instance, wheat, alfalfa—grain of any description—we flood; while on the same soil, for orchard or garden truck, we run it through rows, as we call it.

The CHAIRMAN. Explain how you flood.

Mr. HALL. We flood by running contour levels.

The CHAIRMAN. Explain that so that anybody who never saw it done could understand it.

Mr. HALL. We will take a piece of land, find what slope it has, and then we use whatever the soil will stand. For instance, if it were a level piece, we would use 1 foot of elevation. If the land have a slope of 5 feet to the mile, and if we wanted to flood, we would throw contour levels all around a foot above the highest side of the check. Below the main canal we would go down until we gained a foot elevation, and there we would throw a check or level all the way round. If we were going to use a check 17 or 18 inches and allow for settling so that it would be 18 inches when finished, we would continue the whole field in that shape, setting boxes to draw away from one check to another.

The CHAIRMAN. When you irrigate, what do you do?

Mr. HALL. If it be near the main canal, we turn the water through into a lateral that feeds this field—turn it into a box that empties the first check.

The CHAIRMAN. How long do you flood the land?

Mr. HALL. Until the entire check is covered.

The CHAIRMAN. Until all the land in that check is covered?

Mr. HALL. Of course. On the lower side it would be just 1 foot deep, and if it were even, the other side would be just covered, and it would take just according to the size of the check. The more level the land, the larger the check. For instance, if there were 5 acres in a check, it would take two hours and a half of our stream, with the head we run, to fill that check.

The CHAIRMAN. Would not the time depend on the head of water?

Mr. HALL. Yes. We throw a head of water sufficient to fill those checks in two hours and a half.

The CHAIRMAN. Immediately it is filled, do you commence to draw it off?

Mr. HALL. Yes, unless in certain seasons, when they let it remain for two hours. If the land should be dry or it should be some place where the earth was compact and sloped and would not take the water easily, we would let it take up what water it could, and then we would draw it off into the next check.

The CHAIRMAN. Then you would fill the next check in the same way?

Mr. HALL. Exactly. We do not depend on our head of water for the second check—the check immediately above—because we would soon run out of water. And the laterals are so formed that they fill each check. We fill from laterals, from each end, and also from the check above, making three checks and averaging two hours and half to each check.

The CHAIRMAN. In those two hours and a half you put it on the grain?

Mr. HALL. Yes, cover the ground entirely.

The CHAIRMAN. Does the water being on that length of time injure the grain?

Mr. HALL. No, not in this country.

The CHAIRMAN. How long might it run on the grain in this climate without injury to it?

Mr. HALL. When it is necessary to irrigate grain it is always in the spring of the year or late summer, when it is not so hot. I do not think it would injure it were it to remain six or eight hours. We have had it on grain 12 hours without injury.

The CHAIRMAN. What character of crops do you produce on this ranch?

Mr. HALL. We have this season barley and oats. I do not remember whether they put in any wheat or not. Last year we had plenty of wheat and alfalfa, all kinds of garden vegetables, and red and white clover. Red and white clover grow well here.

The CHAIRMAN. What is an average crop of wheat here?

Mr. HALL. That I could not say.

The CHAIRMAN. What is your crop of barley?

Mr. HALL. We will raise a little over 32 bushels to the acre. Some of it went 40 bushels, and so on.

The CHAIRMAN. How is it with oats?

Mr. HALL. I could not say offhand; but Mr. Cunningham can give you the exact figures on that. It was something over 30 bushels.

Senator JONES. Did you locate the ditches that are on this plantation?

Mr. HALL. All of them except the first four miles of the main line. That was done by Mr. Eldridge, of Colorado.

Senator JONES. In locating those ditches, how far down have you examined the soil?

Mr. HALL. In depth?

Senator JONES. Or any other way?

Mr. HALL. In making ditches we have no reason to go down more than 3 or 4 feet.

Senator JONES. You have not examined the subsoil more than to that depth?

Mr. HALL. Nothing more than where wells have been dug.

Senator JONES. Is the soil, so far as you know, uniform in character?

Mr. HALL. Yes.

Senator JONES. As far as you have gone down; as far as the ditches have gone?

Mr. HALL. I think so. For 8 or 10 feet perhaps you will strike a little gravel. On the higher benches it is deeper with gravel.

Senator JONES. In coming out of Yakima we noticed some land that was very gravelly, with considerable sized stones in it, and a little more sandy than this is. Would there be any difficulty in putting irrigating ditches through that soil?

Mr. HALL. No.

Senator JONES. Would it be as irrigable?

Mr. HALL. Yes.

Senator JONES. And as productive as this?

Mr. HALL. Yes, in some things. In wheat and alfalfa just as well.

Senator JONES. Are there any farms where the subsoil is so open that it would render irrigation impracticable?

Mr. HALL. No.

Senator JONES. You think the whole valley could be irrigated?

Mr. HALL. Yes. But there are some spots over in the Yakima Valley that are hardly worth irrigating, and some percentage of the land—scabby land they call it—where the rocks are on the surface.

Senator JONES. Are you familiar with the valley of this river down to the mouth of it?

Mr. HALL. No.

Senator JONES. How far down are you familiar with it?

Mr. HALL. I could not say whether I was familiar with it below the Moxie Valley.

Senator JONES. Your information is local.

Mr. HALL. Yes; although what I saw was first-class land.

Senator JONES. Have you noticed the flood volume of this river to say how much greater it is than the low water?

Mr. HALL. Yes.

Senator JONES. Is there much difference in it?

Mr. HALL. A great difference, yes. It covers the whole river bottom. I have seen it when I suppose it was from a mile wide to two miles and a half—something like that. It overflowed the banks.

The CHAIRMAN. Have you ever, in California or here, had your attention called to the storage of water in lakes, reservoirs and flats?

Mr. HALL. Not exactly had my attention called to it; but I have thought of it and read of it.

The CHAIRMAN. After what you have read, in going over the ground have you thought about it when you observed the places where it could be stored?

Mr. HALL. Oh, yes, I have seen pretty good locations in this country for storage reservoirs.

The CHAIRMAN. State where those locations are.

Mr. HALL. In the upper Yakima Valley there are storage sites in the Cowlitz.

The CHAIRMAN. What are they?

Mr. HALL. Lakes and streams.

The CHAIRMAN. What is there at the head of these streams, so to speak? What is the topography of the country?

Mr. HALL. Probably the elevation is something like a thousand feet above the Yakima—from 900 feet to 1,000 feet.

The CHAIRMAN. Have you ever traced one of these streams to its source?

Mr. HALL. I have.

The CHAIRMAN. What did you find at its source?

Mr. HALL. Fine land. Take the south branch of the Cowlitz. I was at the head of that.

The CHAIRMAN. Is there any opportunity there for storing water?

Mr. HALL. The whole of the cañon could be used.

The CHAIRMAN. I do not believe in cañons; do you?

Mr. HALL. Well, it depends on how the cañon is formed. I have no more to say about that; but I think it would be a fine place to store water.

The CHAIRMAN. In looking for places for storage reservoirs what do you bear in mind? Do you look for a flat place?

Mr. HALL. Yes; you want a basin as large as practicable. The size of it depends on the country to be irrigated, of course, from that point. That would be my idea of it; and it would not be altogether necessary to have any particular shape. Of course, if it were very large in area and not such a deep cañon it would lessen the pressure of the water on a dam and make it easy to build and less expensive.

The CHAIRMAN. And safer?

Mr. HALL. And safer. And it would hold as much water.

The CHAIRMAN. With your experience as a surveyor, what would you say as to the usefulness of surveys and maps of all these places and streams where reservoirs could be made? Would or not a knowledge of the facts enable settlers to make farms?

Mr. HALL. I think it would be very useful to have them.

The CHAIRMAN. Showing the cost of construction and having the reservoir sites reserved?

Mr. HALL. Yes; and showing the quantity of water in each stream annually; that is, at its lowest estimate.

The CHAIRMAN. You would want the quantity that could be stored in a watershed and how much land would be covered. Those would be important considerations.

Mr. HALL. And to show the amount of water there was without storing. It would show then whether or not they could depend on water without storage.

The CHAIRMAN. In other words, you think it would be very important to have a survey showing the facts in regard to the various localities?

Mr. HALL. Yes.

The CHAIRMAN. If that were done, would it facilitate the settlement and irrigation of this country?

Mr. HALL. I think it would. That is, if water could be brought to cover all this land that is lying waste, you might say, I think the country would be settled very rapidly.

The CHAIRMAN. Are there many places where works could be constructed by private parties?

Mr. HALL. There are a few, but hardly in this age. This is a new country, and \$50,000 or \$100,000 is quite a sum. In 10 years it will not be considered so much.

The CHAIRMAN. Are there no places where you could perfect a few farms with less expenditure than that?

Mr. HALL. I do not think that there are in this country. The country when you come to get up into the foot-hills or leave the flat, level lands becomes quite rough, and it would be more expensive to construct reservoirs for storing the water—a little more than farmers would want to expend.

The CHAIRMAN. While you might not construct reservoirs at once could you not find places where they would be convenient?

Mr. HALL. If that were done under a system it would be well, but it would be more costly to the farmer. He would construct a little one at first and then construct a larger one afterward.

The CHAIRMAN. But a survey would be necessary to show the facts?

Mr. HALL. I would want a survey to show the facts at first, and then the remedy could come afterward.

The CHAIRMAN. Are the settlers able to do that themselves, as a rule?

Mr. HALL. I should not say that they were at present, on any grand scale. Of course, you could get a nook to catch some little water; but as to the general country that is not possible.

The CHAIRMAN. I am talking about the places first. If the facts were known, to what extent could it be done by individuals?

Mr. HALL. I have not thought it over in that light. When I look at the matter I think of the whole country.

Senator REAGAN. Have you made an estimate of the amount of water that is necessary to irrigate an acre of ground?

Mr. HALL. I have always used as a standard one cubic foot for one quarter-section of land.

The CHAIRMAN. Per minute?

Mr. HALL. Per second.

The CHAIRMAN. For how long a time?

Mr. HALL. The irrigating season—as long as you are using the water. We estimate 4 cubic feet per second to a section of 640 acres.

The CHAIRMAN. Do you require more water for corn than you do for grain?

Mr. HALL. I think not. I do not think it takes any more. It takes it in smaller quantities and continually, you might say; because we let it run through the rows almost continually; but in flooding we use so much more at the same time. I think there is a little more water used in flooding than would be in the row.

The CHAIRMAN. You use more water on grain than you do on alfalfa and the other grasses?

Mr. HALL. Yes. Let me understand you. You ask me whether we use more water on grain than on alfalfa?

The CHAIRMAN. Yes, and other grasses?

Mr. HALL. No; I think we use more water on the alfalfa than on the grain.

The CHAIRMAN. What other grasses do you raise here?

Mr. HALL. I do not believe we have anything, except timothy.

The CHAIRMAN. Does that grow here?

Mr. HALL. Yes, pretty well.

The CHAIRMAN. What kind of fruits do you raise on this land?

Mr. HALL. I am particularly interested in that part of it; apples, peaches, pears, prunes, grapes, and such things.

Director POWELL. What do you think of the economy of flooding as compared with the other system in the utilization of water; which method takes the most water?

Mr. HALL. I think flooding takes the most water.

Director POWELL. What ratio—what difference do you make?

Mr. HALL. That depends on the crop that you are irrigating.

Director POWELL. As a general average (I do not ask for details), would a third more water be necessary by flooding than by the row?

Mr. HALL. Yes, I think we use a third more by flooding than by the row,

Director POWELL. How many times do you irrigate wheat?

Mr. HALL. I could hardly give an answer to that, because it is owing to the season. Take a season like this last, for instance, when there has been a good deal of wind, which dries out the surface quickly, and we have to irrigate more often than at other times when there are less winds.

Director POWELL. Have you made any estimate of the cost of your plant? What has it cost per acre on this river to get the water on to the land? I do not mean during a season, but to bring the water into the principal canals and laterals.

Mr. HALL. I could hardly say right off hand. We have built the main line here for three miles and a half, or such a matter, at a cost of \$4,490, in round figures, per mile, except this around the hill. That Mr. Eldridge did before I came here. It cost in the neighborhood of \$4,000 a mile.

Director POWELL. That would cost from \$1.25 to \$1.50 an acre to get the water into this ditch?

Mr. HALL. Yes.

Director POWELL. You have water here for 20,000 acres?

Mr. HALL. Yes, we have that much land.

Director POWELL. How many miles of ditching?

Mr. HALL. About 7 miles in the main line.

Director POWELL. Then the ditches cost what?

Mr. HALL. Thirteen thousand eight hundred dollars, all told, as shown by the books of the company.

STATEMENT OF B. A. CUNNINGHAM, OF YAKIMA.

The CHAIRMAN. What is your occupation?

Mr. CUNNINGHAM. I am secretary to the Moxie Company.

The CHAIRMAN. How long have you been its secretary?

Mr. CUNNINGHAM. Nearly two years.

The CHAIRMAN. What amount of land have you under cultivation on this ranch?

Mr. CUNNINGHAM. Grain, 203 acres; growing alfalfa, 240 acres; 21 under hops, 14 in corn, and 17 in tobacco. We have 10 acres in garden and orchards and 787 in natural hay in the ranch part, subirrigated by the river.

The CHAIRMAN. What is the average crop of wheat?

Mr. CUNNINGHAM. We have raised no wheat to amount to anything. We had a few acres in wheat, but we did not repeat the experiment.

The CHAIRMAN. Do you know from other experiments in the neighborhood what is the average crop per acre?

Mr. CUNNINGHAM. There is none raised except by us.

The CHAIRMAN. What is the average crop of barley?

Mr. CUNNINGHAM. Forty-five to 47 bushels this year, the second year's cropping from the sage brush.

The CHAIRMAN. What is the average crop of oats? Have you raised oats?

Mr. CUNNINGHAM. Yes, we have 35 bushels to the acre on poorer land than that on which the barley was raised.

The CHAIRMAN. Do you produce corn?

Mr. CUNNINGHAM. Yes, we have a very fair stand of corn.

The CHAIRMAN. Have you reaped a harvest?

Mr. CUNNINGHAM. No. We can not tell about that. The corn grows pretty well.

The CHAIRMAN. Do you know how many bushels of potatoes you produce to the acre?

Mr. CUNNINGHAM. No, I can not tell you. We get 1,200 bushels out of the garden; but I could not tell you about the exact acreage.

The CHAIRMAN. You say you raise tobacco?

Mr. CUNNINGHAM. Yes.

The CHAIRMAN. Is that a success?

Mr. CUNNINGHAM. We have made cigars, and they have been pronounced as good as any domestic cigars in America. We have now four cigar makers at work in the factory.

The CHAIRMAN. How is the plant; does it grow well?

Mr. CUNNINGHAM. It thrives luxuriantly. In the opinion of a tobacco expert, who is a resident here, it is a great success. He is this year growing for fillers and binders—letting the wrappers alone.

The CHAIRMAN. What amount of land can be irrigated by your main ditch?

Mr. CUNNINGHAM. We have about 7 sections down here. I could not tell you that.

The CHAIRMAN. How many acres of land have you to irrigate below that?

Mr. CUNNINGHAM. That is not a fair question.

The CHAIRMAN. You could measure what good land there is below the ditch?

Mr. CUNNINGHAM. Four thousand acres.

The CHAIRMAN. About how many acres of land is there to be covered by the main ditch?

Mr. CUNNINGHAM. About 4,000 acres, I should think. It is all arable. I know that, but I do not know the acreage.

The CHAIRMAN. What was the cost of construction of the main ditch that brings water to this amount of land?

Mr. CUNNINGHAM. According to the books it is between \$13,000 and \$14,000; that is, for the main ditch alone. That does not include any lateral work.

The CHAIRMAN. Where this land has been prepared by means of checks for flooding what has been the expense per acre to prepare it?

Mr. CUNNINGHAM. I understand from the engineer \$8 an acre, exclusive of the farm work; from \$5 to \$8 according to location.

The CHAIRMAN. After it has been once put under check, prepared for flooding, does it have to be checked every year or are they permanent works?

Mr. CUNNINGHAM. These are permanent works.

The CHAIRMAN. Then what is the cost of irrigating by flooding the land after you have it once checked with permanent works?

Mr. CUNNINGHAM. Two men will run over that whole checked field in four days.

The CHAIRMAN. Then the expense is light after it is checked.

Mr. CUNNINGHAM. Yes; the expense is very trivial.

The CHAIRMAN. What is the cost of irrigating your land by flooding as compared with the cost of irrigating by means of furrows through the land?

Mr. CUNNINGHAM. The land that we have irrigated by furrows is so small and trifling in extent we can not compare the expense. I do not suppose 5 per cent. of the land is irrigated by furrows.

The CHAIRMAN. You have not compared the expense?

Mr. CUNNINGHAM. No; we have not compared it.

Senator JONES. How often do you irrigate crops?

Mr. CUNNINGHAM. Alfalfa twice to each cutting; that is to say, once immediately before the hay is taken and once during the growth of the crop.

Senator JONES. What time do you begin?

Mr. CUNNINGHAM. We begin according to the season. I think it was about the middle of March or beginning of April we started this year.

Senator JONES. When did you make your first cutting?

Mr. CUNNINGHAM. About the 20th of May.

Senator JONES. When did you make your second cutting?

Mr. CUNNINGHAM. Exactly five weeks afterward, and the next four weeks afterward.

Senator JONES. When will you cut your fourth crop?

Mr. CUNNINGHAM. This week.

Senator JONES. How many more will you cut?

Mr. CUNNINGHAM. Two.

Senator JONES. And two irrigations to each crop?

Mr. CUNNINGHAM. Yes.

Senator JONES. How much do you get per acre out of each cutting?

Mr. CUNNINGHAM. From a ton and a quarter to a ton and a half. The middle cutting is the best cutting we have had yet.

Senator REAGAN. Four and six times a year?

Mr. CUNNINGHAM. Yes; or we shall have cut four times this week, and will have cut six times before the season is out. The age of the oldest field is three years.

Senator REAGAN. Do you use the hay on the farm or do you sell it?

Mr. CUNNINGHAM. We use it for our own range cattle in the winter and for our horses.

Senator REAGAN. Does it improve with age?

Mr. CUNNINGHAM. It has every year.

Senator REAGAN. Do you know how long it will improve with age?

Mr. CUNNINGHAM. No; it has improved every year. We sowed a third of clover with alfalfa, and calculate that the fourth year the roots will kill the clover and still give us a heavy crop.

Senator JONES. How often do you irrigate your other crops—barley and wheat?

Mr. CUNNINGHAM. If the wheat will sprout with the natural moisture of the season, a good spring, you do not need to irrigate it over three or four times during the season. If you have to irrigate the sprout to bring the grain from the ground, you have to irrigate more.

Senator JONES. Do you sow wheat in the spring or in the fall?

Mr. CUNNINGHAM. Altogether spring wheat—barley—we have no wheat.

Senator JONES. You irrigate how often, if it should sprout without irrigation?

Mr. CUNNINGHAM. We irrigate about three or four times if it should come up above the ground without irrigation.

Senator JONES. You sow how soon?

Mr. CUNNINGHAM. So soon as the frost is out of the ground.

Senator JONES. What time is that?

Mr. CUNNINGHAM. February or March.

Senator JONES. How do you irrigate your hop fields?

Mr. CUNNINGHAM. By furrows.

Senator JONES. How frequently?

Mr. CUNNINGHAM. We have to irrigate the hops more than any other crop.

Senator JONES. Then it requires more water for hops than for any other crop?

Mr. CUNNINGHAM. Yes.

Senator BEAGAN. What is the alfalfa worth this year?

Mr. CUNNINGHAM. Ten dollars in the stack. A man across the river sold a cutting the other day for \$10.

Senator JONES. Do you feed any other stock with alfalfa except horses?

Mr. CUNNINGHAM. Yes, we feed it to hogs.

Senator JONES. Green?

Mr. CUNNINGHAM. Yes, green as green can be.

Senator JONES. Regularly during the season?

Mr. CUNNINGHAM. We have done it ever since the alfalfa was high enough to cut. We would like to show you the hogs that have been fed on alfalfa. And the expense is very trivial.

Senator JONES. Do you give them other feed?

Mr. CUNNINGHAM. None, unless it is a brood hog, suckling pigs, and then alfalfa hurts the milk and hurts the pigs.

Senator JONES. How much of the year do you feed hogs on alfalfa?

Mr. CUNNINGHAM. We have fed them ever since about the middle of April.

Senator JONES. Up to what time?

Mr. CUNNINGHAM. Up to now, and propose to go on feeding them with it up to October, and then we will put them on dry cracked barley. That is about five weeks. We expect to produce bacon here for 4 cents a pound.

The CHAIRMAN. The whole cost of raising the hogs and all?

Mr. CUNNINGHAM. Yes, everything.

Senator JONES. You stated that the cost of the main ditch on this plantation was between \$13,000 and \$14,000. What is the length of that ditch.

Mr. CUNNINGHAM. I can not tell you.

Senator JONES. Do you know the windings of it? You know whether it is more than 1 mile or less than 50? Does that include the ditch that was constructed by some other engineer prior to Mr. Hall's coming here?

Mr. CUNNINGHAM. I understand it includes the whole cost of the works, as per the ledger.

Senator JONES. The company's main ditch is a little over 7 miles?

Mr. CUNNINGHAM. Yes.

Senator JONES. What is the size of the main ditch?

Mr. CUNNINGHAM. It is about 8 feet on the bottom and 2 feet on the slope. It carries 2½ feet of water.

The CHAIRMAN. That depends on the size of the ditch?

Mr. HALL. If it stood on a height or steep bluff we would not use more than a foot to a foot and six-tenths. But on land like this you can use 2 feet.

The CHAIRMAN. How is that different?

Mr. HALL. It is more liable to cut on the side of the hill. The nature of the ground on each side of the hill is different to what it is on a flat; and to make it safe we use a smaller gate. The exact cost of the ditch is \$4,490 a mile from here down. We constructed it for 9 cents a yard.

Adjourned.

NORTH YAKIMA, WASH., *August 13, 1889.*

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), Reagan and Jones; also Director Powell.

STATEMENT OF JOHN T. KINGSBURY, OF NORTH YAKIMA.

The CHAIRMAN. How long have you resided in Washington Territory?

Mr. KINGSBURY. Ten years.

The CHAIRMAN. How long have you lived in the arid region?

Mr. KINGSBURY. Since 1869.

The CHAIRMAN. What is your profession?

Mr. KINGSBURY. I am a civil engineer.

The CHAIRMAN. Have you traveled pretty generally over the mountain regions of the West?

Mr. KINGSBURY. Pretty well.

The CHAIRMAN. What Territories have you traveled over and are you most familiar with?

Mr. KINGSBURY. Wyoming, Nevada, Utah, Oregon, Washington Territory, California, Arizona, New Mexico, Texas, and Kansas. For thirty years I have been acquainted with those.

The CHAIRMAN. Have you given much attention to the subject of irrigation?

Mr. KINGSBURY. Yes.

The CHAIRMAN. And to the topography of the country?

Mr. KINGSBURY. Yes.

The CHAIRMAN. And to the water supply for irrigation?

Mr. KINGSBURY. Yes.

The CHAIRMAN. What extent of land approximately should you suppose there is in Washington Territory that can be irrigated and that requires irrigation? Is it a large or small area?

Mr. KINGSBURY. Quite a large proportion of the whole quantity of land.

The CHAIRMAN. To what extent has irrigation been practiced in Washington Territory and how long has it been practiced? Of course I do not wish you to enter into details, but state generally.

Mr. KINGSBURY. About less than twenty years from the start. In a very small way some farmers have combined and taken out small and easy ditches together at a little cost.

The CHAIRMAN. Have there been any large enterprises set on foot in that respect?

Mr. KINGSBURY. No.

The CHAIRMAN. Are the opportunities for small enterprises of that kind exhausted, if you take into consideration the storage of water and utilization of all the land that can be reclaimed by small enterprises?

Mr. KINGSBURY. No.

The CHAIRMAN. Would a survey which would designate the works to be constructed and the places where water could be stored be of service to this section of the country, and to what extent would it aid in the development of new enterprises with moderate capital, that would be useful in utilizing the water for irrigation?

Mr. KINGSBURY. It would develop a very large area for a nominal sum, you might say, in comparison with what it would accomplish.

The CHAIRMAN. What is the impediment to settlers coming here

now and utilizing these available places? Is it the want of exact information which could be had from surveys and estimates?

Mr. KINGSBURY. It is almost entirely for the lack of knowledge, and that knowledge would be acquired by surveys, so that the people living here and those that are to come could tell at what cost the work could be done and how it could be done and where it could be done.

The CHAIRMAN. That is the principal difficulty, as I understand you, in the settlement of the arid region where irrigation is not expensive?

Mr. KINGSBURY. Yes; so far as small outlays are concerned.

The CHAIRMAN. Without attempting to be accurate, state what is the extent of the possible irrigation with small outlay.

Mr. KINGSBURY. Take, for instance, the valley of the Yakima. There could be in a distance of 150 miles along its course 200,000 acres probably brought under cultivation at small expense; then with a combination of capital that could be extended into a million.

The CHAIRMAN. You mean into a million acres that might be watered by this water shed?

Mr. KINGSBURY. Yes; and even a million and a half.

The CHAIRMAN. A million and a half might require larger works and reservoirs in the mountains to store water?

Mr. KINGSBURY. Yes.

The CHAIRMAN. When you have been in the mountains have you observed the opportunities for storing water?

Mr. KINGSBURY. Yes.

The CHAIRMAN. Are they good?

Mr. KINGSBURY. There are splendid opportunities at reasonable expense for such works. Of course the easier places for storage would be used first, and then the number of reservoirs would increase as population increased.

The CHAIRMAN. There is no question of the productiveness of this soil, I suppose, when water can be had?

Mr. KINGSBURY. None whatever.

The CHAIRMAN. Do you find true of other places in the Territory and in the arid region what you find true here?

Mr. KINGSBURY. To a great extent.

The CHAIRMAN. I mean particularly; do you find true on other rivers in Washington Territory what you find true on this river?

Mr. KINGSBURY. Yes.

The CHAIRMAN. And so through the arid regions generally?

Mr. KINGSBURY. Yes.

The CHAIRMAN. Then would you regard as valuable to the people a survey by the Government of its land with a view to irrigation and reserving places for hydraulic works and storage; also giving estimates of cost, with exact information of any other character that would enable the people to see what could be done toward increasing the facilities for agriculture?

Mr. KINGSBURY. Most assuredly. I regard that as the first and most important subject for the development of this section of the country.

The CHAIRMAN. A great deal of the public land would be disposed of quickly to settlers if they had exact information of that character, would it?

Mr. KINGSBURY. Yes; people would come here by the hundreds and thousands, if they could be informed of the probabilities of irrigation. If the people of Yakima could write east and give exact information of this character, eastern people would come here in large numbers.

The CHAIRMAN. Is the amount of land in eastern Washington that

does not require irrigation very extensive, compared with that which does require irrigation?

Mr. KINGSBURY. The amount of land that will produce cereals in Washington is quite large.

The CHAIRMAN. Is there a large amount of land that will produce all-around crops?

Mr. KINGSBURY. Yes. There is very little of the eastern portion of Washington Territory that would grow crops without artificial irrigation.

The CHAIRMAN. Then is it your opinion that the portion now producing cereals in abundance would be largely benefited by irrigation?

Mr. KINGSBURY. Yes; it would produce twice as much at least, even in the first year. Any ordinary work of irrigation that might be done would pay the first year in a very much larger yield of grain and other crops.

The CHAIRMAN. Have you ever seen farming in any other country?

Mr. KINGSBURY. I was raised in New York and have been in the Southern States.

The CHAIRMAN. How would you compare in productiveness a well-cultivated and irrigated farm here, where irrigation has been properly done, with a farm in western New York?

Mr. KINGSBURY. I was raised in Genesee, N. Y. Without doing much in the way of irrigation the people here can more than double the eastern crop.

The CHAIRMAN. Does this refer to the cereals and all-around crops?

Mr. KINGSBURY. It refers to both; although as to corn I would not say that. We here can not reach Kansas or Illinois with corn crops.

The CHAIRMAN. How is it as to potatoes?

Mr. KINGSBURY. We raise as good potatoes here as anywhere in the world.

The CHAIRMAN. What would be a good crop of potatoes on irrigated land here?

Mr. KINGSBURY. Five to six hundred bushels to the acre.

The CHAIRMAN. What would be a good crop of wheat?

Mr. KINGSBURY. About 35 bushels.

The CHAIRMAN. And what a good crop of oats?

Mr. KINGSBURY. Sixty bushels.

The CHAIRMAN. Of barley?

Mr. KINGSBURY. Barley would give 50 bushels; that is rather a small yield for barley, but in the experience that I have had here I have never seen barley at its best.

The CHAIRMAN. Do you raise some alfalfa here?

Mr. KINGSBURY. Yes.

The CHAIRMAN. After that has been well set and is two or three years old, so that you get a fair crop if properly irrigated, how much can be produced on the acre each year?

Mr. KINGSBURY. From 6 to 10 tons. Six would be a small yield. I should say 7 tons as an average.

Senator JONES. You stated that you knew of fine opportunities to irrigate tracts of land in a small way with a reasonable outlay. I would like to ask you what a reasonable outlay, in that sense, would be? What would you consider a reasonable outlay per acre for the irrigation of land such as you have spoken of?

The CHAIRMAN. You mean the outlay to be made in order to get the water to the land?

Senator JONES. Yes. Those general expressions do not convey a very definite idea.

Mr. KINGSBURY. From \$3 to \$5 an acre would be what I should call a reasonable outlay, to start with.

Senator JONES. What proportion of the entire area of Washington Territory is susceptible of cultivation with or without irrigation?

Mr. KINGSBURY. I can not tell you how it is west of the mountains so much as I can on this side.

Senator JONES. This side of the Cascade Mountains, do you mean?

Mr. KINGSBURY. Yes.

The CHAIRMAN. What proportion of the Territory on this side is susceptible of cultivation?

Mr. KINGSBURY. With the storage of water that could be effected we could cultivate three-fourths of the land east of the mountains.

Senator JONES. Of all the land east of the mountains?

Mr. KINGSBURY. Of all the land in Washington Territory east of the mountains.

The CHAIRMAN. Would all that require irrigation?

Mr. KINGSBURY. The higher lands would not; that is, for the crops that would grow. But the greater portion of that, or at least 50 per cent. of that, would need water.

Senator JONES. And would be practically valueless without water?

Mr. KINGSBURY. Yes; practically valueless for farming purposes. Take the water away from it and it would be of no value.

The CHAIRMAN. I will say to the gentlemen who are present that this committee is seeking information as to whether it would be profitable to the Government to have surveys made which would locate reservoirs and lines of ditches for irrigation purposes, and to ascertain the cost of such works. Reservoir sites and sites for ditches are now by act of Congress reserved so that the Government can take them, and individuals can acquire no title to them. The inquiry we are prosecuting is to what extent, if these surveys are made, the people will be able to avail themselves of the lands, and of the water, and to make homes. The Government has not undertaken, nor has it been suggested that the Government should itself undertake, such works by direct Government appropriation.

The first thing to do is to ascertain what we have. We want such information as shall indicate whether these surveys would be useful, and whether it would pay the Government to expend money for them. We do not want the idea to go abroad that the Government is going to turn the rivers or anything of that sort. The idea is to enable the people who come here to have exact and definite information as to how irrigation can be practiced at a reasonable expense. When the population shall have increased largely, the question of enterprises that involve great expense will be considered. If they are not taken hold of by private enterprises, then it will be a problem for the State or the nation to consider hereafter. I will suggest to this board of trade that it might collect information as to the particular streams in this locality and the means of storing water, and send it to the committee within a reasonable time.

STATEMENT OF LUTHER S. HOWLETT, OF NORTH YAKIMA.

The CHAIRMAN. Can you give the committee some information on the subject which it is investigating?

Mr. HOWLETT. The Tietan River is one of the principal feeders of the Naches River. This Tietan River is fed by the snows of the Cas-

cade range, and as it comes on to join the Yakima River it runs through a deep gorge, which would make a most excellent natural reservoir. That gorge can be made into a little inland lake. If that were done it would bring the water to the rim of an immense basin.

The CHAIRMAN. Could that not be tunneled through so as to draw pretty much the entire lake to begin with?

Mr. HOWLETT. There is no lake there. The dam of the Tietan River would make a lake that would hold an immense body of water that now runs entirely to waste.

Senator JONES. How much?

Mr. HOWLETT. I will ask Colonel Cock to say how much.

Mr. COCK. It would be a space of 3 or 4 miles wide and 6 or 7 miles long.

Mr. HOWLETT. It would be fully as large as that. That would bring it to the rim of the lake, where private enterprise could take it and water the sides of the mountains. It has occurred to me that that is the one great scheme right in our immediate valley. Of course on the other side the Columbia River could be drawn upon *ad libitum*. An exhaustless supply of water can be brought from that onto the east side of the Yakima River. From the west an immense storage lake could be made, which would water the mountain sides all around us.

The CHAIRMAN. What is the general character of the land on the east side of the Columbia River, if the Columbia River could be taken out?

Mr. HOWLETT. I am not familiar with that.

Senator JONES. Is there any land immediately in the valley of that river where you propose putting down this dam that would be reclaimed by irrigation?

Mr. HOWLETT. There are thousands of acres.

Senator JONES. How large a country is there in the valley of that stream that would be tributary to that lake?

Mr. HOWLETT. Not any in the valley of that stream. That stream would be cut off near where it empties into the Yakima.

Senator JONES. What quantity of land would there be that would be reclaimed by the water stored in the lake, and how near would it be?

Mr. HOWLETT. There would be at least twenty-five townships.

Senator JONES. Each 6 miles square?

Mr. HOWLETT. Yes. It could be carried across into the reservation, which we hope will soon be opened. It could be carried clear to the Columbia River. I have understated rather than overstated the possibilities in that respect.

Senator JONES. Would you include in those twenty-five townships all this valley down to the mouth of the river?

Mr. HOWLETT. No. Twenty-five townships really understates what can be done.

Senator JONES. I should like to know what amount would be in proximity to this lake, that would be reclaimed by it; I don't mean what land would be reclaimed by a large expenditure of money.

Mr. HOWLETT. There would be a piece of land 20 miles one way by 11 or 12 the other.

Senator JONES. In the immediate neighborhood of that lake?

Mr. HOWLETT. Yes; right between the town and the lake.

Senator JONES. Is that land comparatively level?

Mr. HOWLETT. No; it is rolling land, but all excellent land.

Senator JONES. Would it be practicable to irrigate it?

Mr. HOWLETT. Yes.

Senator JONES. It is not too rolling to irrigate, you think?

Mr. HOWLETT. No; some of our best farms are of that character.

STATEMENT OF J. R. LEWIS, OF NORTH YAKIMA.

The CHAIRMAN. You understand the purpose of the committee's inquiry. Will you please state anything that will be of service to us in that connection?

Mr. LEWIS. I have resided in this Territory since 1872. I traveled in the eastern part of this Territory as judge of this district for three years, and I went all through eastern Washington. In these valleys of the Yakima, including the Nachez Valley and the Yakima Valley proper, and the valleys tributary to the Yakima, the irrigating season commences in the months of May and June principally. Very little land west of the Columbia River, in what is known as the Columbia River basin, is susceptible of cultivation without irrigation except, perhaps, for hay. Many people produce hay along the river by sub-irrigation. In May and June, when we need water ordinarily, our streams are higher than at any other season of the year. The short season for cropping in this country is when very little snow has fallen during the preceding winter, because in that season you find the mountain streams almost dry. There was no snow last winter.

With regard to the question of storage of water, the finest store-house we have is our snow-clad mountains. Fort Adams is an everlasting store-house. The waters of the Yakima and the Tietan flow in there in ordinary seasons, and without any storage whatever those would irrigate an extremely large area of country.

People coming here from the States east look upon irrigation as practically implying starvation. They do not know anything about it. People from California and Colorado adapt themselves readily to this country. They know what irrigation means. With a moderate expenditure of money by the Government surveys could be made all over the valleys of the Yakima, the Tietan, the Atanah, and through the Indian reservation, and would furnish information to settlers as to the proper places from which to get water and to which to take it. That would aid very much, in my opinion, in the immediate settlement of this country. As it is, everybody who comes here is at sea, and has no idea of what is the proper thing to do. The line of inquiry, therefore, on which this committee is engaged is one that if it results in an exhaustive survey of the country will greatly add to the development of the arid region.

Upon the question of the production of crops my experience and observation show me that for a wheat crop 45 to 50 bushels is a fair average on the base of the Blue Mountains. In this country 40 bushels is a pretty large crop of wheat. You can get 60 bushels of oats here on well-irrigated land, and from 60 to 75 bushels of barley on well-irrigated land, but there is very little ground in this vicinity that is properly irrigated. The Kittitas Valley is well irrigated, and you will find men talk of 75, 80, and 100 bushels of barley, and truthfully so, because they have the system established. On the Indian reservation just below us here, which must shortly be opened, there are 300,000 acres of land that can be irrigated. I do not think I overestimate it. There are 200,000 acres that are sub-irrigated and produce hay now. There is plenty of water here now in ordinary seasons to irrigate some of the land.

Senator JONES. What do you mean by sub-irrigation?

Mr. LEWIS. Sub-irrigation is seen where the land lies along the streams and the water percolates under the soil and spreads out from the stream some considerable distance, say from a quarter to half a mile. While on that subject I will call the attention of the committee

to this fact: That if you go over to Moxie, where you were this morning, you will find that the soil can not be properly irrigated without flooding. The water will not percolate through it. I own a ranch in this neighborhood myself, and ran a ditch through it, the water of which percolates into the soil, and I got my crops entirely by irrigation.

The CHAIRMAN. As to the economical use of the water and to avoid disputes arising from questions of priority of right and so forth, is it or not important that the survey should proceed with the idea that the people would want to take out the most water and cover the most land possible in the beginning? Is there anything in that idea, or is it just as well to let them take it out as they please? You may state to the committee, if you have formed a judgment, what system you would recommend.

Mr. LEWIS. My experience develops positively this fact, that we use about twenty times as much water on every farm as there is any necessity of. Out of 20 parts there are 19 parts wasted. That is a small estimate. If you have surveys made the people will know exactly where to take that water and where to put it back again, and thereby they will get the most value out of the least quantity of water, simply by knowing how to do.

My experience has been a little expensive in that matter. With a few other gentlemen I expended several thousand dollars in surveying on the Moxie. After expending that money we found we could not do what we wanted to do. If the Government had done that surveying we would have had the thing done by the Government. A pioneer wants to make a living with the smallest possible expense. If he has a survey at hand he knows exactly what he can do. If the pioneers can not make a combination of capital, they can make a combination of muscle; and if the Government will give them the survey the settlers will furnish the muscle.

Senator JONES. Why did you expend several thousand dollars on the Moxie scheme?

Mr. LEWIS. We undertook to carry water out from the Yakima, beyond the Home ranch on the Moxie farm, several miles out, and we discovered after making the survey that we would have to spend several hundred thousand dollars to make a flume. I donated the survey to the railroad—the only thing I ever gave the Northern Pacific. My remembrance is that that thing cost us \$5,000. If the Government will put some money into a proper survey it would, in my opinion, be a very good way to apply a part of the money in the Treasury.

The CHAIRMAN. I understood you to say that those coming here from irrigated regions were better prepared to enter into the business of irrigation than those coming from Europe or the East?

Mr. LEWIS. Yes; the people of the States west of here understand the subject better.

The CHAIRMAN. People coming here from the East and from Europe are unprepared to do farming by irrigation or to undertake irrigation works, because they have not the inclination or the money to make surveys or explorations?

Mr. LEWIS. Yes.

The CHAIRMAN. If they had accurate information as to what should be done and what can be done, what is to prevent the people of the East from coming here and making good homes?

Mr. LEWIS. Nothing. They would adapt themselves immediately to the country, because a farm of 40 acres in this country, if irrigated,

will produce more clear money than a section in the Western States put down in grain.

Mr. HOWLETT. And the farmer would save three or four years' time.

Mr. LEWIS. A California or Nevada man will come in here and will take a farm somewhere by a stream and will have it irrigated in three weeks, and have it blooming in a very short time. He knows just how to go to work at it and what to do with it. But take a man from the Eastern States; he comes here and looks over the country and concludes that starvation stares him in the face, and if he has money enough to go back he goes.

The CHAIRMAN. Then your conclusion is that a survey is very important?

Mr. LEWIS. Exceedingly so.

Senator JONES. It is "exceedingly important," as I understand you, in order to save private individuals from wasting money in foolish experiments?

Mr. LEWIS. More than that. It is not only to save them from wasting money, but also to prepare the country for immediate development. The settler can not come here because he knows not what to do.

Senator JONES. I have an idea that if irrigation were proceeded with in a proper way a large amount of land could be used by means of irrigation; whereas, if it is done in a thoughtless way, it is possible to waste large sums of money. I do not regard as a public purpose any expenditure on the part of the Government as being in order to save private individuals from getting their fingers burnt in bad investments. This country should be made to support families and develop homes as quickly as possible, but I think private individuals should expend their money in making farms and developing their own property. It ought not to be done at the expense of the Government.

Mr. LEWIS. My idea is this: A settler comes up the Naches River to make a home. He has no money to make surveys. If he had he might waste the money and not succeed in making any farm. If the Government had surveyed the property and mapped out a plan of irrigation, a settler could come in there and go to work at once and develop as far as belongs to his property the details of the system of irrigation mapped out by the survey. In that way he could at once make his farm available for crops, because he would know how and where the water was to be had.

STATEMENT OF H. D. COCK, OF NORTH YAKIMA.

The CHAIRMAN. Please state to the committee anything that occurs to you in connection with the need of this Territory for irrigation.

Mr. COCK. I would call the attention of the committee to what we see immediately around us. Four years ago the town of North Yakima was a sage plain. There was but one little cluster of trees here to prove that it was not absolutely a sage plain. You see what has been done by one small stream in four years. We are carrying through the town about 900 inches of water, not as the miners measure it, but by actual flow. We find that a $\frac{1}{2}$ -inch hole will admit water enough to irrigate a town lot 50 by 150 feet, if properly handled.

The CHAIRMAN. Without pressure?

Mr. COCK. Yes; without pressure. It is simply the natural flow. The trees which you see here along the street prove to your own eyes, without any statements from anybody, what can be done through this whole valley by a little irrigation. Every tree in this town I set out in

May, 1885—just four years ago. I think that fact is stronger than any argument that can be adduced in support of irrigation.

The CHAIRMAN. What are the dimensions of the supply ditch?

Mr. COCK. It is 7 feet wide on the bottom now and 10 or 12 feet wide on the top. It varies a little in the flow. It is now flowing through a gate, and runs about 900 inches. By actual measurement to-day at my head-gate we are carrying 800 inches, and we have a surplus.

Adjourned.

ELLENSBURGH, WASH., *August 13, 1889.*

The committee met pursuant to call of the chairman;

Present: Messrs. Stewart (chairman), Jones, and Reagan; also Director Powell.

STATEMENT OF S. W. BAKER, OF ELLENSBURGH.

The CHAIRMAN. Mr. Baker, I understand you are secretary of the Board of Trade, and speak by request for the people of Ellensburg.

Mr. BAKER. I do.

The CHAIRMAN. What is the extent of the arable land that can be irrigated in this valley, of which Ellensburg is the principal town?

Mr. BAKER. Two hundred thousand and eighty acres.

The CHAIRMAN. Have you a sufficient supply of water to irrigate all the lands which can be covered by the flow of the streams?

Mr. BAKER. Yes.

The CHAIRMAN. Is there any portion of the valley which can not be covered by the flow of the Yakima River? If so, are there any other streams which can be utilized?

Mr. BAKER. No.

The CHAIRMAN. Has any attention been paid by persons engaged in irrigation to the question of storing water in reservoirs? If so, what are the opportunities for such storage?

Mr. BAKER. Little or no attention has been paid to this matter, but there are excellent opportunities for such storage, as all of the smaller streams flow from narrow cañons easily dammed.

The CHAIRMAN. Would an accurate survey, showing the source of supply of water, the means of obtaining it, whether by ditches alone or by ditches and reservoirs, and also showing the extent of land that could be irrigated and the estimated cost, be beneficial in enabling settlers to make homes in this valley or in this part of the Territory of Washington? Inquire into this branch of the subject carefully and give as much detailed information as possible touching the benefits of such survey, it being the object of the committee to ascertain whether the United States would be justified in making surveys in view of the expense and the benefits to the settlers and to the Government in disposing of its lands. Give the results of irrigation, the kinds of crops produced, the average yield of the various crops when the land is properly cultivated, and state to what extent fruits and vegetables of all kinds can be raised; giving as nearly as practicable the number of acres under cultivation, and stating some cases of what has been done by individual farmers in this vicinity in reclaiming lands without the aid of capital.

Mr. BAKER. Yes, such survey would do a great deal toward settling what are now called dry portions of the valley. Thousands of acres

now considered worthless, except for grazing, would be proven to be cultivatable, and efforts would be made to construct the necessary canals. The Kittitas Valley without water is but a sage-brush desert; but upon being irrigated it becomes a garden spot and produces bountifully of cereals, fruits, and vegetables, which can be equaled no where else in the Territory. About 22,000 acres of land are under cultivation in the valley, the average production of wheat being about 42 bushels to the acre; oats, 70 to 80. All small fruits, as well as apples, plums, pears, etc., grow to perfection; peaches do not do so well, except in localities bordering on the Columbia and Wenatchee Rivers. Vegetables of all kinds and of the finest quality are grown upon every farm, and are noted in the Puget Sound country for their great size and flavor. It is nothing uncommon for cabbage to weigh 50 pounds and upward; onions, 5 pounds, etc. Every farm in the valley is an example of individual effort in reclaiming the desert with muscle and water.

The CHAIRMAN. What is the cost per acre of the original plant for irrigation, and what does it cost per acre to irrigate the lands annually?

Mr. BAKER. Where water is bought from the farmers' ditch, the only one in the valley, the charge for water is \$1.50 per miner's inch, it being estimated that it takes 1 inch to the acre for a season's irrigation. One man can irrigate 160 acres, the expense for work being nominal. Our system is very simple, requiring no previous knowledge whatever, the water being usually allowed to run through the fields in small ditches a rod or more apart. Flooding is not practiced here.

The CHAIRMAN. State whether or not there is any permanent arrangement about this matter of irrigation, whether the farmers are at the mercy of the owners of the water, and whether the latter can refuse to give the water to the farmers and regulate the price thereof.

Mr. BAKER. As stated previously, there is but one ditch owned in the valley, the majority of the stock in same being held by farmers. The owners charge what they please for water, and have refused in some instances to allow persons not owners of such stock to use water from the ditch.

Adjourned.

WALLA WALLA, WASH., *August 15, 1889.*

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), Jones, and Reagan; also Director Powell.

STATEMENT OF W. H. REED, OF WALLA WALLA.

The CHAIRMAN. What is your occupation?

Mr. REED. I am a farmer and a grain commission merchant.

The CHAIRMAN. How long have you resided in Walla Walla?

Mr. REED. Eleven years.

The CHAIRMAN. Are you familiar with the country in this vicinity or any portion of the country in eastern Washington or Oregon?

Mr. REED. I am familiar with everything south of the Snake River and east of the Columbia.

The CHAIRMAN. Describe the Walla Walla River and its branches first. What kind of country is that section and how much is there of it?

Mr. REED. The Walla Walla River rises in the Blue Mountains,

which are situated about 20 to 25 miles south of the town of Walla Walla.

The CHAIRMAN. How prominent a range is the Blue Mountain range?

Mr. REED. It is from about 5,000 to 6,000 feet high, and runs for about 100 miles through this part of the Territory.

The CHAIRMAN. Is it a spur of the Cascades or is it an independent range?

[A VOICE.] It is an independent range.

The CHAIRMAN. What other streams head in the Blue Mountain range?

Mr. REED. There are numerous streams between the Snake River and the base line of the Territory. All head in that mountain range; but they are comparatively small streams—what we call creeks.

The CHAIRMAN. What is the character of the country to the north, where it is watered by these streams—the general character? Is it agricultural land?

Mr. REED. It is agricultural land. It is all rolling table-land. That is practically all there is here and along the bottom of these streams—bottoms, flat country.

The CHAIRMAN. Do they raise crops over this country without irrigation?

Mr. REED. Yes; that is to say, wheat, barley, and rye.

The CHAIRMAN. Do they raise all-round crops—vegetables, fruit, etc.?

Mr. REED. No; they require irrigation. The vegetables will grow without irrigation, but most of them require irrigation. And fruits require irrigation, except in the mountains.

The CHAIRMAN. Has irrigation been practiced much in this region?

Mr. REED. Not to any great extent. Along these streams there are bottom-lands lying contiguous to the streams that are to a small extent irrigated, and they grow crops of fruit, but to a very limited extent.

The CHAIRMAN. Is water abundant for the purpose of irrigation?

Mr. REED. That is the great difficulty, the water is not abundant. We are already having trouble about the lack of water in the city, because so much of it is taken from the creeks that the mills are unable to run. Notwithstanding the small amount of irrigating that we are doing, we are in trouble with our water supply.

The CHAIRMAN. Mills can be run without water, can they not?

Mr. REED. They can be run by steam. But these mills can not, because they have not the steam.

The CHAIRMAN. But with desert land you can not do much without water?

Mr. REED. No.

The CHAIRMAN. So that in this country, I think, in time the water for irrigation purposes will take the place of water for domestic purposes. Have you ever examined the matter with the view of establishing reservoirs and increasing the water supply?

Mr. REED. No.

The CHAIRMAN. You have never thought about that?

Mr. REED. No. There are tracts of land in the Blue Mountains, areas of a section, half a section, a thousand acres, that there is no doubt could be utilized in that way if water could be got on to them.

The CHAIRMAN. What is the character of those tracts of land?

Mr. REED. Level spots, some timbered and some untimbered. Some of them are meadows.

The CHAIRMAN. They could by dams be turned into lakes?

Mr. REED. Well, I do not know how the water could be gotten into them,

STATEMENT OF JOHN M. HILL, OF WALLA WALLA.

The CHAIRMAN. Are you familiar with the country lying east of the Cascade Mountains, the country comprising eastern Washington and Oregon?

Mr. HILL. I am pretty well acquainted with the country east of the Columbia River and south of the Snake River. I have been living here 18 years.

The CHAIRMAN. Describe the country in regard to its water and land, stating anything you may know about irrigation so far as it has gone.

Mr. HILL. I think Mr. Reed has pretty well described the portion of land in this vicinity. In fact, that is the general character of the country on the base of the Blue Mountains right through. There are small streams or creeks putting out of those mountains at very short distances and taking in the Walla Walla. You have spoken of the Walla Walla. That is the stream just south of us. That is the largest stream in this vicinity. Then we have, some 40 miles on the east of us, the stream known as the Tukannon.

The CHAIRMAN. And between the two rivers numerous streams?

Mr. HILL. Yes. The first is the Tukannon and the next is the Touchet.

The CHAIRMAN. Has any effort been made to use these streams for irrigation?

Mr. HILL. Not to any great extent, with the exception of a few farmers living immediately on the creeks. After they get out of the mountains, out on to what we call the flat mountains, at the foot of the mountains along the base till we get to an elevation of 1,500 feet, right in this immediate vicinity, they do not require this irrigation.

The CHAIRMAN. How is the ground moistened there; by rain or seepage from the snows?

Mr. HILL. By rain. The rain increases.

The CHAIRMAN. As you get to a higher altitude?

Mr. HILL. When you get back on the mountains. We have from 4 to 6 feet of snow back in these mountains every winter. We had 4 feet in the vicinity of a saw-mill in which I am interested. The snow, as a general thing, melts very rapidly. It does not melt slowly enough, that is, to give moisture to the ground.

The CHAIRMAN. When you get farther away from the mountains, I understand you need irrigation.

Mr. HILL. We need irrigation, that is, to raise all classes of crops.

The CHAIRMAN. Can you raise small grains every year without irrigation?

Mr. HILL. We follow the plan of summer fallowing here, to some extent. We have better success and are more sure of crops by summer fallowing. Between here and the Columbia River it would be well to have irrigation; it would increase the quantity and quality of the crop every year.

The CHAIRMAN. For vegetables you need irrigation everywhere?

Mr. HILL. Except on the creek bottoms and the lands near the snow. It does not require irrigation on these heavy loamy bottoms.

The CHAIRMAN. Have you given any thought to the matter of the irrigation of the country generally?

Mr. HILL. I have not given any great amount of attention to it. I have given attention to it since this question has been agitated. Having read of it in the papers I have been looking at the streams in the

mountains to see what my judgment would amount to.

The CHAIRMAN. What do you say on that subject?

Mr. HILL. I think our country is well adapted to the establishment of reservoirs. I think we have as nice a place for establishing reservoirs as any country.

The CHAIRMAN. Now, I wish to ask you whether or not you think a survey of this country for the purpose of ascertaining the points where reservoirs could be established and having them and the lines of ditches designated, with estimates of doing the work, would be beneficial to the people, and whether it would tend to increase the immigration and thus enable the Government to dispose of its land and settle up the country?

Mr. HILL. I think it would. I think the establishment of reservoirs through our country would make it certain and sure of bringing a good deal of this land that is now raising poor crops of grain to produce fruits and vegetables.

The CHAIRMAN. And grain too?

Mr. HILL. Yes; better crops of grain.

The CHAIRMAN. Have you any idea of what is done in the way of crops on an acre of irrigated land either by seepage or by having the water turned on to it?

Mr. HILL. The papers published a statement, which I can not now call to mind, to the effect, however, that where irrigation is used the crops are enormous.

Senator REAGAN. What character of crops do you raise here?

Mr. HILL. Our principal crop is wheat. We raise some oats and barley, but the exports are principally wheat and barley. We ship barley east.

Senator REAGAN. Are those crops raised on irrigated land?

Mr. HILL. Not generally; raised on land that is not irrigated.

Senator REAGAN. What would be the crop per acre with irrigated land?

Mr. HILL. That is not the general way of raising those small crops, so I would hardly be able to answer that question.

Senator REAGAN. What is the average yield on unirrigated land?

Mr. HILL. It ranges all the way from 20 bushels to 60 bushels of wheat.

Senator REAGAN. Without irrigation?

Mr. HILL. Without irrigation. That is owing to the slope of our country. The higher we get the more wheat we get.

Senator REAGAN. What is your crop of barley?

Mr. HILL. From 40 to 100 bushels. I have raised 40 and I can raise 100.

Senator REAGAN. Will corn grow and mature here?

Mr. HILL. Yes, it does.

Senator REAGAN. How much corn do you raise?

Mr. HILL. I can not answer that question, because the raising of corn is not generally followed in this country.

Senator REAGAN. What other crops besides wheat and barley do you raise here?

Mr. HILL. We raise some oats on these high lands.

Senator REAGAN. What is the yield per acre on high land?

Mr. HILL. That I am unable to answer, because I can not answer positively that we will raise a given crop of oats.

Senator REAGAN. Have you seen experiments to determine how much would be the increase of production upon this land if it were irrigated?

Mr. HILL. I think it would be double.

Senator REAGAN. What kind of fruit do you raise here?

Mr. HILL. I think we raise almost any kind that there is anywhere, except tropical fruits. We raise peaches and plums. The peach crop is not a sure crop every year, but prunes, plums, grapes, and fruits of that kind grow well.

Senator REAGAN. Do apples grow well?

Mr. HILL. Apples grow quite well.

Senator REAGAN. Do the small fruits, such as strawberries and raspberries, grow well?

Mr. HILL. Strawberries and raspberries grow as well here as they do any place in the world.

Senator JONES. How long have you lived here?

Mr. HILL. I was born on this coast. I have lived at Walla Walla eighteen years.

Senator JONES. What is your business?

Mr. HILL. I am interested in the milling and flume business. I also do some cattle farming, and am concerned in the street railway in the city.

Senator JONES. Do you reside in this town?

Mr. HILL. I do.

Senator JONES. How many inhabitants have you here?

Mr. HILL. Between 6,000 and 7,000.

Senator JONES. Is this the county seat?

Mr. HILL. Yes.

Senator JONES. What is the population of the county?

Mr. HILL. Eleven thousand.

Senator JONES. Then more than half the population of the county live in this town?

Mr. HILL. Yes.

Senator JONES. About what is the size of the county?

Mr. HILL. We have been cutting it up—seventy-two school sections and just half the number of townships—thirty-five townships.

Senator JONES. About what proportion of the land in this county is arable; that is to say, if it have tillage?

Mr. HILL. Three-fourths of it at least. Of course a great deal of it is rolling country, but we farm rolling land and very steep land.

Senator JONES. What proportion of what is suitable for tillage is fit for agriculture with irrigation?

Mr. HILL. Half of it, at least.

Senator JONES. How much land in the immediate vicinity of this town is under cultivation and irrigation?

Mr. HILL. The greater portion of our land in the immediate vicinity of Walla Walla is farmed in some shape or other, either in raising grains or fruits.

Senator JONES. Is it irrigated?

Mr. HILL. Not the grain land.

Senator JONES. The grain land is not irrigated?

Mr. HILL. No.

Senator JONES. Are some parts of every farm irrigated and some parts not?

Mr. HILL. No; the farms irrigated are only those lying along these creeks.

Senator JONES. Those back from the creeks are not irrigated?

Mr. HILL. Those back from the creeks. First we have a small hill and then we have the table and rolling land.

Senator JONES. Is there any grain in the county that is irrigated?

Mr. HILL. There is west of us on the Walla Walla River. They used to irrigate considerable there, and also on the Touchet.

Senator JONES. How long has irrigation been practiced to any great extent in this vicinity?

Mr. HILL. Ever since I have been in the country there has been some.

Senator JONES. How long has it been practiced to any considerable degree?

Mr. HILL. It is only within four or five years that we have received complaints by the mills of a shortage of water.

Senator JONES. Is there any desire on the part of the people on the bottoms to irrigate them?

Mr. HILL. I have no doubt there is a desire, but there is a lack of water. So far as getting water onto this table land is concerned it is a short distance. Our country falls to the west all the way from 50 to 80 feet to the mile. So that in taking water out of these streams you would not go a great distance before you would get water on these table lands.

Senator JONES. You think they could get water on these table lands?

Mr. HILL. I think so, if there were a water supply.

Senator JONES. You have not observed any comparison between land cultivated without irrigation and the same land subsequently irrigated?

Mr. HILL. No; I have not. I do not call to mind anything of that kind at present.

Senator JONES. You have a general idea that it would double the crop. Of course, there is land here that will raise no vegetables at all without irrigation. But when you put water onto it it will raise the finest kinds.

Mr. HILL. Fruits are successfully raised where they irrigate.

Senator JONES. On the table lands?

Mr. HILL. Yes.

Senator JONES. Do they raise peaches and pears up there without irrigation?

Mr. HILL. Oh, yes.

Senator JONES. Then fruit-growing is not confined to irrigation districts?

Mr. HILL. No; not entirely.

Senator JONES. Have you any idea of the relative value of land with and without water; what it would be worth? Take a tract of 40 acres worth \$10 an acre without water, what would it be worth with water? What would be the increase in the value of the land?

Mr. HILL. Double—I say that at once—if not three times. I know a short time ago I bought 10 acres and paid \$350 an acre for it, because it is right near town. I bought it for a home, and then it has a nice stream of water running through it.

STATEMENT OF C. A. ELMER, OF WALLA WALLA

The CHAIRMAN. What is your occupation?

Mr. ELMER. I am the editor of The Daily Union.

The CHAIRMAN. Have you given any attention to the effect of irrigation in this vicinity?

Mr. ELMER. Other than the collection of a certain amount of statistics in reference to the cultivation of grain and vegetables, I have not.

I have something to refresh my memory in regard to the vegetable line. You have alluded to the value of irrigated lands and the total amount of crops from irrigated lands, and I have a statement that I made from information that I got together from the gardeners. It is as follows:

The first efforts to grow trees between the Cascades and Rocky Mountains were by Missionaries Spaulding on the Clearwater River, and Whitman at his residence on the Walla Walla River; both these attempts were made in the spring of 1837, when seeds were sown. In this connection Mr. Philip Ritz, the oldest resident tree-grower, says: "I remember seeing some of the apple trees about the year 1866, and they run over a foot in diameter and nearly 30 feet high. Some of the fruit was of very good flavor; these, I believe, were the first apple trees to come into bearing on the Pacific coast, and known and spoken of from Victoria to San Diego."

After this first effort by the missionaries there was not much done in the way of fruit-tree culture until 1861, when Mr. A. B. Roberts, of Walla Walla, and Mr. James W. Foster, at the foot of the mountains, both of whom planted large orchards, some of which are bearing fruit now.

The third attempt at fruit-growing was by Red Wolf, a chief of the Nez Percé tribe of Indians, at the mouth of the Alpowa Creek; Rev. Spaulding planted the seed for him in the spring of 1838. In the spring of 1859 Mr. Clark set out a nursery about 1½ miles south of the town of Walla Walla, on Yellow Hawk Creek. In the fall of the same year James W. Foster brought fruit trees from over the Cascade Mountains and set them out on his present ranch. Thus Mr. Clark became the first nurseryman, and Mr. Foster the first to set out an orchard, after Missionaries Spaulding and Whitman, between the Cascade and Rocky Mountains. In 1860 A. B. Roberts planted a nursery and set out what is now known as the Ward orchard in the city limits.

In the fall of 1861 Mr. Ritz delivered a number of orchards east of the Cascade Mountains from his Oregon nursery, the shipment consisting of between 30,000 and 40,000 trees, many of which are at present, and have been for years, bearing excellent fruit. In 1862 Mr. Ritz moved his nursery from Corvallis, Oregon, to this valley. He started a nursery about 1½ miles from Walla Walla, planting about 60,000 trees, which in 1872 was increased to nearly 1,000,000 trees.

To-day Mr. Ritz has 70 acres in trees and cultivates all varieties adapted to this northern climate, having in his nursery 400 different varieties of apples, pears, and prunes, and has in bud 250,000 plum and prune trees ready for next year's planting. This, we believe, is the largest stock ever grown by one man north of California. These trees will bear fruit within two or three years from planting.

As to vegetables and small fruits, I offer the following facts, gathered by me during the past season:

There was during the past season, within a radius of 2 miles of Walla Walla, over 1,000 acres cultivated as vegetable and small fruit gardens, and the value of their product was to exceed \$400,000, all of which was marketed in this Territory, Idaho, Montana, eastern Oregon, and points to the southeast as far away as Denver.

The writer, desiring to get some figures showing the average yield of the garden lands of Walla Walla and their marketable value, called on W. S. Offner, the leading market gardener, and received the following information in regard to average yields of "garden truck," under ordinary cultivation, by the acre:

Onions, 25 tons, at \$12	\$300
Potatoes, 20 tons, at \$10	200
Carrots, 50 tons, at \$6	300
Cabbage, 15 tons, at \$15	225
Table beets, 20 tons, at \$15	300
Stock beets, 40 tons, at \$6	240
Grapes, 10 tons, at \$60	600
Strawberries, 10,000 pounds, at 6 cents	600
Blackberries, 12,000 pounds, at 7 cents	840
Raspberries, 5,000 pounds, at 7 cents	350
Melons, 300 dozen, at \$1	300
Asparagus	300
Tomatoes, 600 boxes, at 30 cents	180

This gives a total for 13 acres of garden for one year's crop, of \$4,735. Mr. Offner further said, the cost of the land would not exceed \$2,600 with a good fence around it; \$500 will pay for necessary improvements, such as the planting of the berries, grape vines, and asparagus, and \$500 will purchase a team and the necessary imple-

ments to cultivate the garden. This makes a total investment of \$3 600. The cost of planting, cultivating, gathering, and marketing the crop from a garden of 13 acres will not exceed \$1,500. Taking this as an experiment, the total investment up to the end of the year 1888 would have been \$5,100, and the receipts for one year's crop would be \$4,735. The profit upon the investment would be \$3,235, or nearly 100 per cent.

Our informant was the first to commence gardening upon a large scale, and the smaller gardeners laughed at him, believing that he would glut the market with his products and thus produce his own downfall. Instead of that, in the first year he could not fill the orders received, and he doubled the size of his garden. The next year it was the same, and he again increased the size of his garden. Still he says that the only difficulty experienced in retaining his customers is because he can not half fill the orders received.

One of the reasons, besides the advantage of location, why Walla Walla fruits and vegetables have a market is because of the early season here. Berries and vegetables are in the market here as early as they are in California, and are of even finer quality.

The CHAIRMAN. What has been your observation and your opinion as to the need of irrigation ?

Mr. ELMER. In my opinion there is no demand for it in the higher portion of the valley, on the high lands. There the grain yields largely without irrigation.

The CHAIRMAN. Nearly every year ?

Mr. ELMER. Yes.

The CHAIRMAN. But from here down to the river. How would it be there ?

Mr. ELMER. Much of it produces small crops, because of a lack of water at the right season. That is to say, if they had the water to put on from May until the grain was ripened, the yield would be much greater.

The CHAIRMAN. With regard to the production of crops other than small grain. How does irrigation affect them ?

Mr. ELMER. There are no crops of grain of which I know in this vicinity that are irrigated.

The CHAIRMAN. I speak of crops other than grain.

Mr. ELMER. As many potatoes and vegetables are raised in many portions of the valley without as with irrigation. In some portions, where there is alkali, water is required.

Senator JONES. Where these crops grow there is moisture either by seepage or from rain-fall ?

Mr. ELMER. Yes ; there is a natural irrigation in certain portions of the valley.

The CHAIRMAN. How is it with fruits ?

Mr. ELMER. Much the best fruit that I have seen in the valley is raised without irrigation. But that which is marketed at the present time is raised by irrigation.

The CHAIRMAN. Where is the land situated on which you can raise fruit without irrigation ?

Mr. ELMER. Most of it is above, near the mountains, within a few miles of the city. There, when you rise above a hill, you will see a rolling bench.

The CHAIRMAN. Is there more rain-fall as you gain an elevation ?

Mr. ELMER. Yes.

The CHAIRMAN. That is general here—the lower the land, the lower the rain-fall.

Mr. ELMER. Yes ; that is the need all over this section.

STATEMENT OF H. S. BLANFORD, OF WALLA WALLA.

The CHAIRMAN. How long have you resided in Walla Walla?

Mr. BLANFORD. I have been here since November, 1885, as Signal Service observer. I am a sergeant in that corps.

The CHAIRMAN. To what extent are you familiar with the country about here?

Mr. BLANFORD. I have lived all through the valley from here to the Cœur D'Alene Mountains, and for two years I was at Dayton. That is in the Walla Walla Valley. I am pretty familiar with the Walla Walla Valley—climate and rain-fall especially.

The CHAIRMAN. Where is the rain-fall in this valley?

Mr. BLANFORD. It increases as you go up the valley, gain a higher elevation, on the upper slope. For instance, here we have 18 inches annually on an average, and at Dayton, 30 miles away, it is 27 inches.

Senator JONES. How much higher is Dayton than it is here?

Mr. BLANFORD. Walla Walla has an altitude of 1,000 feet, and it rises 60 feet to the mile.

Senator JONES. How much of this valley is table-land and suitable for raising small grain without irrigation?

Mr. BLANFORD. Most of it. The land between here and Wallula is pretty light. After you go down here 6 or 7 miles it is very light—sage brush will grow up to the town within 2 or 3 miles.

Senator JONES. Do you regard sage-brush as indicating bad land?

Mr. BLANFORD. It is drier land. At Wallula the rain-fall is 9 inches.

Senator JONES. Sage-brush land is dry land. But how as to its fertility?

Mr. BLANFORD. With plenty of water it will produce fine crops of fruits and berries.

Senator JONES. You have not seen it irrigated with small grain?

Mr. BLANFORD. No; I have not. I have had no experience with irrigated land on which there is grain.

Senator JONES. On what portion of this valley do you raise fruit without irrigation?

Mr. BLANFORD. Almost any part of it. There are some few belts that have very peculiar climates, where you can not raise peaches. But they raise fine peaches in Dayton. Dayton is famous for its peaches, and they are up 1,675 feet. They raise apples there also.

Senator JONES. Without irrigation?

Mr. BLANFORD. Yes.

Senator JONES. There you have 18 inches more of rain-fall?

Mr. BLANFORD. Yes.

Senator JONES. Does it come every season?

Mr. BLANFORD. It rains almost exclusively every day from the middle of September until January. June has a little rain-fall. I think the larger orchards are not irrigated at all, but the garden peaches and the small berries in a great many instances are irrigated.

Senator JONES. What is the difference between those irrigated and those not?

Mr. BLANFORD. Of course, where the land is light and irrigated, you get as good crops as you do on land not irrigated. Water seems to be essential.

Senator JONES. What are the chances of getting water on to these lands where it is required?

Mr. BLANFORD. I should say that the water supply is not sufficient

to irrigate all the land that might be irrigated. There is such a fall of the creek that you could get water almost any distance.

Director POWELL. Suppose we go down 25 miles on the Walla Walla, what would be the rain-fall there?

Mr. BLANFORD. Down the valley?

Director POWELL. Yes.

Mr. BLANFORD. If you go down 25 miles you would get 10 inches.

Director POWELL. What at this place?

Mr. BLANFORD. Eighteen inches—17½.

Director POWELL. Going up the river 10 miles, what would be the rain-fall?

Mr. BLANFORD. Twenty or 21, easy. If you were to go straight across here to the foot of the mountains you would get 30 inches.

Director POWELL. If you were to go 35 miles east what would it get?

Mr. BLANFORD. Thirty-five miles, at the city of Dayton, you would get 27 inches; that is at the foot of the bluff.

Director POWELL. Are there any rain-gauges on the top of the mountains?

Mr. BLANFORD. No; none.

Director POWELL. How high up the Blue Mountains do you have rain-gauges?

Mr. BLANFORD. This is the highest here. A man in Pendleton had a rain-gauge, but I do not know exactly what it is there. But we had observations at Dayton for five years, and we made the average about 27 inches.

Director POWELL. And Dayton is the highest point where you have had rain-gauges?

Mr. BLANFORD. Yes. At Lewiston, that is in the Snake River Valley, they have 14 inches. But Dayton has a bluff, and on the top of that hill there must be a great deal more rain-fall than in the valley. That is the finest wheat land in the world.

Senator JONES. How high are the Blue Mountains?

Mr. BLANFORD. I should say from 4,500 to 5,000 feet.

Senator JONES. Have you any distinct idea about the rain-fall over on the mountains?

Mr. BLANFORD. No; except that it increases very fast between here and the mountains.

Senator JONES. But you have no data as to the increase?

Mr. BLANFORD. No.

Senator JONES. It is very much larger than it is at Walla Walla?

Mr. BLANFORD. Yes. Fifteen miles across here you would get double the Walla Walla rain fall. I should like to present as part of my statement the following in relation to the weather for last year, 1888.

The CHAIRMAN (examining). Let it be filed.

The statement is as follows:

The month of December, 1887, was mild and equable. Its mean temperature was 40°; the highest 63° on the 7th, and the coldest 20° on the 22d.

Winter weather set in January 4, after which date there followed twenty days of cold weather, which was all the winter we had. Of these twenty days, ten had temperatures below zero, the coldest being 17° below zero on the 16th. The weather during this cold snap was generally calm, dry, and clear, and few knew how cold it was until they inspected a thermometer. January had a mean temperature of 22° above zero—quite cold for us—but we have the consolation of thinking that we were in such distinguished company as Boston, 20°; New York, 26°; Cleveland, 22°; St. Louis, 24°, and Salt Lake City, 23°, and that our winter lasted less than three weeks, while theirs approximated four months.

The chinook came January 2, and King Winter abdicated in favor of Gentle Spring. Thenceforth mild weather continued. February had a mean temperature of 45° and

its coldest day's lowest temperature was about the freezing point. Its highest temperature was 65°. Only nine days were cloudy and the continued sunshine and warm winds made lilac and fruit trees leaf out. There were little snow-squalls on the 28th and 29th which did no harm, the snow melting immediately.

March had spring-like but capricious weather. A little cold wave came over on the 6th, 7th, and 8th, the temperature fell to the freezing point and a sprinkle of snow fell. After this the weather was delightfully pleasant. The month had twelve cloudy days, a mean temperature of 45°, and a highest temperature of 71°.

April was warm, sunshiny, and comparatively dry. The mountains invested themselves with the deep-blue atmosphere which indicates the rapid evaporation of their snows by the warm chinook; the hills put on their springtime verdure; trees attained full leaf and, many of them, full blossom, and the chinook wind, whose advent during the winter months was hailed with delight, lost its identity. Our mean temperature for April was 58°.

May was warm, blooming, altogether charming. Walla Walla strawberries were in the market May 5 and new potatoes on the 28th, by which time everything pertinent to the season in the temperate zone could be had in abundance from local market gardens.

June was cool and unusually wet. July, August, and September were warm and dry. The highest temperatures of the summer were 102°, on July 18 and August 21.

October was warm and pleasant. The first frost of the season occurred October 18, and killed strawberries ripening on the vines and terminated the season of the green peas and other tender vegetables. Rain fell quite heavily during the last week of the month. October had a mean temperature of 56°, and no temperature as low as the freezing point.

Fine autumn weather continued to November 12, when a cold wave came over and a little winter set in and continued, except for occasional mild chinooks, through the month. The highest temperature was 63°, the lowest 18°, and mean 38°. There was no snow and the precipitation was considerably below the normal.

December was mild and cloudy and frequently foggy. Its mean temperature was 36°; the highest 64°, and lowest 18°. About an inch of snow—the first of the winter—fell on December 23. The rain-fall for the month was 2.19 inches, nearly an inch below the normal. The total deficiency in precipitation for the year 1888 was 3.78 inches, which classes among the "dry years" of this country.

As a whole the year has been warm and comparatively dry. The mean annual temperature was: The highest temperature 102°, the lowest 17° below zero. The prevailing wind from the southwest. The total snow-fall, 19 inches; the total precipitation, 13.50 inches; the last frost of spring occurred March 29; the first frost of autumn occurred October 18, with temperature between 45° and 60°; chinook wind blew on 66 days between November 5 and April 30; thunder-storms, 3; clear days, 187; fair days, 115; cloudy days, 113; rainy days, 86; foggy days, 4.

The careful study of the records for the past fifteen years would seem to warrant the observation that when, as in the present year, there is a period of cold weather in the latter part of November and early in December, the remainder of December and most of January will be mild and pleasant. There is nearly always a month of cold weather either in January or February.

MR. BLANDFORD. Allow me to add a few words on the general subject. Walla Walla does not consider herself in an arid district. While it is undoubtedly true that abundant irrigation would greatly increase crop-yields and enhance the value of lands, it is equally true that our unirrigated lands are as productive as any in the Northwest and do not strictly need irrigation. Without irrigation we can raise, per acre, 40 to 100 bushels of wheat and barley, 6 to 8 tons of hay, 500 to 700 bushels of potatoes and onions, 100 tons of plums, peaches, apples, etc., and very heavy crops of berries and all small fruits and vegetables. Irrigation, of course, would increase these yields and assure good crops every year, other conditions being favorable.

The secret of getting good crops in the Walla Walla Valley depends on thorough irrigation. My own investigations have shown that, on properly plowed and pulverized summer-fallowed land, there is a continuous stratum of moist earth from the surface to bed-rock. The native bunch-grass sod-land dries out, by evaporation, to a depth of more than 4 feet in a single summer. In other words, all the seasonal rain-fall is evaporated during the season. In this land it is necessary to dig 10 feet or more before reaching the permanent moist earth, while well-har-

rowed fallow will give continuous moist earth from 4 to 6 inches beneath the surface. There are wheat fields in the vicinity of this city which have, for the past twenty-five years or more, given a splendid crop of 35 to 45 bushels of wheat per acre each year in that period. The farmers declare the soil is practically inexhaustible with proper conservation of the annual rain-fall. The same is true of all the good land on the west slope of the Blue Mountains in Washington Territory, where the altitude and yearly rain-fall is equal to or greater than here at Walla Walla.

Table of rain-fall and temperature taken from the records of the United States Signal Service Office at Walla Walla, Washington Territory.

[Compiled for the Senate Committee on Irrigation.]

MEAN TEMPERATURE.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Sum.	Annual mean.
1886.....	25.8	43.2	44.5	52.0	61.4	68.0	76.7	78.9	64.0	50.2	39.8	39.7	.....	53.2
1887.....	41.0	23.0	49.6	51.5	60.9	63.9	75.5	72.3	61.3	51.9	40.8	39.9	.....	52.6
1888.....	22.1	45.4	44.7	58.1	64.8	65.1	72.8	77.9	69.9	56.2	38.4	35.6	.....	54.2
1889.....	28.2	36.0	58.2	57.0	61.2	70.8	78.0	.....	.....	.....	.....	.....	.....	.....

PRECIPITATION (in inches).

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Sum.	Annual mean.
1885.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.92	.....
1886.....	3.45	1.29	1.06	1.66	0.67	0.73	0.02	0.12	0.06	1.95	0.78	4.41	16.39	.....
1887.....	2.36	1.78	1.83	1.87	1.08	2.12	0.03	0.71	1.55	1.52	3.06	2.63	26.44	.....
1888.....	2.21	0.80	1.44	0.69	0.21	2.37	0.46	0	0.02	2.33	0.87	2.19	13.59	.....
1889.....	0.47	0.79	1.39	1.51	4.04	1.33	Trace.	.....	.....	.....	.....	.....	.....	.....

The average annual precipitation of Walla Walla, as taken from the private record of Mr. Isaac Straight, from 1873 to 1886, is 17.85 inches.

STATEMENT OF GEORGE T. BERRY, OF WALLA WALLA.

The CHAIRMAN. How long have you resided in this vicinity?

Mr. BERRY. Since 1864. I have lived in Washington Territory since 1853.

The CHAIRMAN. Describe this valley, its land; how it is situated with reference to its rivers and mountains.

Mr. BERRY. It has been very correctly described by Mr. Reed and Mr. Hill. It has a fall of 60 to 75 feet to the mile, until you get into the mountains; then the streams are from 50 to 60 feet.

The CHAIRMAN. The Blue Mountains are of what altitude?

Mr. BERRY. From 3,000 to 3,500 feet.

The CHAIRMAN. Are there numerous streams coming out of those mountains?

Mr. BERRY. Yes.

The CHAIRMAN. For what distance?

Mr. BERRY. The Walla Walla River runs back into the mountains 25 miles from the base.

The CHAIRMAN. Have you been along the ridge to know the topography of the country there?

Mr. BERRY. I have been all through the mountains clear up to the head of the streams. It has been my business to be there. The streams

are confined to cañons, and the cañons break very abruptly from one creek to another. The heads of the rivers there come very close together and spread out as they come toward the valley. But there are not many table-lands, only in a few places. There are a few meadows, and they go off into the Grande Ronde. But the cañons are many.

The CHAIRMAN. Have you ever been further south than the table-lands—the lands beyond the Blue Mountains?

Mr. BERRY. Yes, I have been clear around the Blue Mountains on the south.

The CHAIRMAN. As far south as the California line?

Mr. BERRY. No. I have been out close to the border line of California, though.

The CHAIRMAN. What is the character of the country?

Mr. BERRY. As you get between the Blue and Cascade Mountains it is high table-land.

The CHAIRMAN. Are there any streams of water through it?

Mr. BERRY. No, not many streams of water; it is a dry country till you get to the John Day's River.

The CHAIRMAN. That comes out of the Blue Mountains?

Mr. BERRY. Yes; it heads in on the southwest side.

The CHAIRMAN. When you get beyond that, there is a region of what you would call desert land.

Mr. BERRY. Yes; on high country.

The CHAIRMAN. What would be the altitude; too high to raise crops?

Mr. BERRY. No; the vegetation is good there and the soil is good, with water on it.

The CHAIRMAN. Is there a large region of country in there?

Mr. BERRY. Yes.

The CHAIRMAN. What is it used for?

Mr. BERRY. Grazing purposes—stock-raising.

The CHAIRMAN. Have you given your attention to the subject of irrigation in this valley?

Mr. BERRY. I have, in this valley.

The CHAIRMAN. What effect has it upon the crops?

Mr. BERRY. It has a very preceptible effect. It increases the yield of everything that we put water on—small grain, fruit, and vegetables.

The CHAIRMAN. How much will it increase the yield of small grain?

Mr. BERRY. I should say that it would double the yield.

The CHAIRMAN. In an ordinary year?

Mr. BERRY. Yes.

The CHAIRMAN. How would it be with potatoes?

Mr. BERRY. It would do that with potatoes, with this amendment; I will say, as Mr. Elmer said, that up near the mountains it would not, because it is heavier, richer soil.

The CHAIRMAN. They do not need irrigation there; they have enough rain-fall to not need it?

Mr. BERRY. Yes.

The CHAIRMAN. But how about below that?

Mr. BERRY. Then it increases very rapidly.

The CHAIRMAN. Clear down to the river?

Mr. BERRY. Yes; I know I planted an orchard ten miles from town on sage-brush land. I drew water out of the Walla Walla River, and it gave an abundant yield. That is the effect of irrigation. It increases the yield of vegetables and small fruits.

The CHAIRMAN. Have you ever given any attention to storing water below the mountains in ravines and small places?

Mr. BERRY. I have often thought the matter over, but never made any surveys for that purpose. In the cañons it could be stored, but there is no way of doing that on the summit of the mountains.

The CHAIRMAN. Could you not turn it out and make a reservoir on your own farm?

Mr. BERRY. No, not successfully. We ought not to tamper with the water, because the people will enjoin us.

The CHAIRMAN. You will have more difficulty here in getting out of the law, because you will have some of the European facts to contend with—you have rain-fall to do something with.

Mr. BERRY. There have been lawsuits already. There have been some in regard to the water in this stream. The people could not get water on to the table-lands, because the persons owning the mills will not allow them to take it out. Those are the facts. And we have not had an opportunity of trying it on a very large scale. But everybody would have water if they could get it. That is the truth of it. It would increase the value of the land. Land worth \$25 an acre to-day would be worth \$300 with water on it. And I call on any gentleman here to verify that statement.

The CHAIRMAN. Do you not think the people will get plenty of water sometime?

Mr. BERRY. Yes.

The CHAIRMAN. Do you not think that the Government of the United States could help some by surveys and the designation of places where reservoirs could be constructed?

Mr. BERRY. I think so.

Major Powell, at the request of the chairman, spoke briefly on irrigation matters.

STATEMENT OF CHARLES HENRY, OF WALLA WALLA.

The CHAIRMAN. How long have you resided in Walla Walla?

Mr. HENRY. About ten years.

The CHAIRMAN. What proportion of land in this vicinity is public land, and how much has been entered?

Mr. HENRY. I can not state exactly how much has been, but I am aware of the fact that there is more vacant and unoccupied Government land in this county than any other in the Territory.

The CHAIRMAN. What is the character of the unoccupied Government land?

Mr. HENRY. It is chiefly arid land; that is the reason it has not been occupied. It lacks moisture.

The CHAIRMAN. To what extent could moisture be put upon it?

Mr. HENRY. If proper efforts were made to catch and store the waters that are wasted in the winter and spring, thousands and thousands of acres could be utilized.

The CHAIRMAN. Of public land?

Mr. HENRY. Yes. If it could be demonstrated to the people that water could be stored and utilized this country would bloom up very quickly. There is an immense scope of country to the west and north that if it had a very little moisture at the right time of the year would afford homes for an immense population.

The CHAIRMAN. Could this be done by individuals, or would it require associations and a large expenditure of money?

Mr. HENRY. I think that if it were clearly demonstrated that water could be applied to the land people would come here and would make

efforts themselves to get the water in. In some places it might require some money to do very much.

The CHAIRMAN. What do you say of the effect of irrigation in this vicinity?

Mr. HENRY. It has been stated here by some gentleman who preceded me that he believed that it would double the yield of our small-grain crops. I believe that it would do more than that, in this way; it would assure us a crop each and every year. As it is now one-half of our land has to lie fallow one year, and it is very unsatisfactory to have to do that. It would be far better for the Government if the people had only small farms of 100 acres and have those well farmed and producing a crop each year, than to let people have 640 acres with one or two hundred lying fallow. You can travel here for miles and miles and you will not see a clothes-line. The land is owned by men of large means, who own it in large quantities, and it is cultivated one part this year and another part next year. It would be much better for the Government and the people if it were farmed in small pieces and farmed thoroughly.

STATEMENT OF W. P. GRAY, PASCO, FRANKLIN COUNTY.

The CHAIRMAN. Where do you reside?

Mr. GRAY. In Pasco, Franklin County.

The CHAIRMAN. Have you paid any attention to the subject of irrigation?

Mr. GRAY. Yes.

The CHAIRMAN. Where?

Mr. GRAY. Where I live; in Pasco.

The CHAIRMAN. What is the character of the soil about Pasco?

Mr. GRAY. It is a sandy loam.

The CHAIRMAN. Have you ever experimented as to the effect of putting water on the soil?

Mr. GRAY. Yes.

The CHAIRMAN. With what results?

Mr. GRAY. With good results. The soil here will produce, if watered, anything that can be produced in semi-tropical climates.

The CHAIRMAN. It is rich soil, is it?

Mr. GRAY. Yes.

The CHAIRMAN. Have you heard people discussing the question whether it was possible to get the Columbia River onto that land or not?

Mr. GRAY. The matter is being agitated now by several parties. I took a party of capitalists from Chicago up into our Territory, up to Aprees Rapids, two weeks ago. My opinion is that there is hardly fall enough in the Columbia to bring it down successfully.

The CHAIRMAN. From Aprees Rapids?

Mr. GRAY. Yes.

The CHAIRMAN. How far is it from those rapids until you reach another rapids?

Mr. GRAY. Forty-five miles.

The CHAIRMAN. How much is the water-fall at this place?

Mr. GRAY. At Cabinet Rapids it is about 10 feet and at Rock Island about 20 feet.

The CHAIRMAN. How much is it at Aprees Rapids?

Mr. GRAY. About 75 feet in 9 miles.

The CHAIRMAN. There is not much fall in the river from there down to Pasco?

Mr. GRAY. Very little.

The CHAIRMAN. Is there about as much as you want in a ditch?

Mr. GRAY. Yes.

The CHAIRMAN. Is there much difference between that part of the river and the part that we see in traveling along the line of the railroad?

Mr. GRAY. No.

The CHAIRMAN. Is there not considerable of that land that is less than 75 feet above the river?

Mr. GRAY. On the Franklin County side, or rather on the Douglas County side—

The CHAIRMAN. That is on the east side?

Mr. GRAY. On the east side. I would estimate that a ditch taken out at the head of Aprees Rapids would cover 30,000 acres of lowland before it got to the eddy at White Bluffs. At that point there would be no land covered for about 20 miles; then about 4,000 would be covered; then for 10 miles more no land would be covered; then there would be covered about 15,000 acres to carry it to the Snake River.

The CHAIRMAN. Making in all about 50,000 acres?

Mr. GRAY. A little more than 50,000 acres. On the west side of the river in the first 30 miles between 40,000 and 50,000 acres can be reclaimed by a ditch from the head of the rapids.

The CHAIRMAN. Have you ever estimated the cost of a ditch of that kind?

Mr. GRAY. The gentlemen who were with me made a very preliminary examination. They had no instruments with them, but took a carpenter's level and put up a tripod of their own; but I do not know what the result of the investigation was.

The CHAIRMAN. Have you looked into the question of irrigation as to the storage of water and the utilization of the small streams?

Mr. GRAY. I have studied the topography of the country somewhat. Near Pasco there are quite a number of coulées or cañons that could be used for storage at a very small cost.

The CHAIRMAN. Is there sufficient rain-fall on the water-sheds?

Mr. GRAY. There is not much rain-fall. You might call it snow-fall. I suppose our average snow-fall is about from 8 to 18 inches. We have two other ways to get water. One is to bring in Moses Lake, which is an alkali lake lying about 60 miles due north, but the supply is hardly enough to justify the expense of bringing the water down.

The CHAIRMAN. How much of a lake is it?

Mr. GRAY. It is about 18 miles long and from 1 to 3 miles wide. It is fairly deep.

The CHAIRMAN. Is there any way of getting a tunnel into it?

Mr. GRAY. Hardly.

Senator REAGAN. There is an artesian well being bored at Pasco, I believe?

Mr. GRAY. Yes.

Senator REAGAN. How deep have they got with it so far?

Mr. GRAY. Five hundred and twenty-seven feet. They found gravel after about 135 feet down, and the remainder is basalt; that goes down to 350 feet.

The CHAIRMAN. They have not got through the basalt yet?

Mr. GRAY. No.

Senator REAGAN. You have no completed well there?

Mr. GRAY. No. But I will say that there is a well at Fulman, which is in Whitman County; and they also have a well on the other side of us at Roslyn. It is about 120 miles to Fulman and about 150 to Roslyn. I understood that the depth of the Fulman well was about 75 feet and the Roslyn well about 350 feet; but that is hearsay.

Senator REAGAN. Is the flow large?

Mr. GRAY. In the Fulman well it is 13 to 18 feet, and at Roslyn I understood it was 8 feet, about. They struck the flowing well, and then went a little farther and struck gas, and now they are throwing together.

STATEMENT OF MARION G. EGBERT, OF WALLA WALLA.

Mr. EGBERT. Irrigation with us exists only in its infancy, being used only for orchards and gardens, and the little that is done in this way soon exhausts all available water, viz, that of the small mountain streams here; but this is especially true during a season that has been so dry as this has been. This is also true in all sections of this country. There are large arid tracts about us which, to the view of the ordinary mortal, will always remain so, for he can not see how water can ever be put upon them, for the reason of their altitude and distance from any large body of water.

At Pasco, some 35 miles from here, is a magnificent body of land, large as a State back East, that produces, with water, wonderful crops, that without it are indeed arid and valueless. Its elevation is but 355 feet, with the great Columbia bisecting it. Yet the people, ever so willing, don't seem to know what to do, where to go to work, to reclaim this beautifully lying and superbly situated body of land. The section named would make the finest orchard land on earth if water was but placed upon it.

Adjourned.

STATEMENT OF JOHN GIBBON, BRIG. GEN. U. S. ARMY, COMMANDING DEPARTMENT OF COLUMBIA.

My attention was directed to irrigation and reclamation of arid land very early in a long term of service on the plains since the close of the civil war. At three of the posts where I was stationed a more or less perfected system of irrigation was kept up, with very great benefit to the garrisons, in the shape of shade trees, grass, and flowers. At Fort Sanders, in the Laramie plains, a stream of water flowing from a large, cold spring several miles above the post was, by means of a graded ditch, conducted along the edge of the valley into and around the post with the usual result—grass, trees, and flowers. This was in 1867.

At Camp Douglas, in 1869, a stream of water from the mountains was running through the post, the water being used to irrigate the lands of the valley below. It was conducted about the post in various directions with the usual result; wherever the sage-brush was cleared off and the water put on good crops followed. Irrigation in Utah was then an old story, for the Mormons had for years made use of it with the finest results.

But the most marked results were obtained at Fort Shaw, Mont. On arriving there in 1870 the post was found to be situated on a dry,

arid plain, with scarcely any grass, and not a tree or bush in sight except in the river bottom 70 or 80 feet below. The year following a ditch $7\frac{1}{2}$ miles long was constructed, tapping the Sun River several miles above the post, running across the broad valley, reaching the foothills and skirting along them, until by a well-graded line it reached the plateau occupied by the post, around which it was conducted in every direction with the usual results. The difficulties here were enhanced by the fact that the ground on which the post was located was a hard conglomerate, into which we were obliged to dig holes for the trees and supply them with some soil, but the hardy, quick-growing cottonwood speedily took root, and water to it being the great essential, it grew rapidly, and a few years afterward the post, on approaching it, was seen to be perfectly embowered in a forest of trees 30 and 40 feet high, forming a marked contrast to its appearance in 1870.

These, however, were not the most important results following the construction of this irrigating ditch at Fort Shaw. It demonstrated the value of the high bench lands for agricultural purposes when supplied with water. In running over the plateau above the post good rich soil was encountered. A portion of this was broken up and irrigated from the ditch. The finest kind of vegetables of all kinds were the result, and the company gardens were at once removed up from the bottom land where they had previously been located, and where vegetation had always been very much retarded from the soil being cooled by the infiltration of the snow water from the flooded river. The bench lands proved much warmer and on them the frost came later in the fall and ceased earlier in the spring, thus giving a longer season. At that time Montana was very sparsely populated, and a large portion of the people were engaged in mining. For this purpose large and long ditches had been constructed, but most of the land cultivated was in low ground and few experiments had been made with the bench lands. So marked was our success with vegetables, that the soldiers sent specimens to the Territorial fairs and carried off the prizes for two successive years for bench land vegetables.

The moistening of the dry, compact earth resulted in the appearance of that important assistant in agriculture, the common earth-worm. The earth-worm soon brought birds, especially the robin red-breast, which not only came to feed in our yards, but built their nests in the trees and raised their broods. All these transformations took place by the simple introduction of water, and exhibit on a small scale the typical changes which will take place on a large one by a more extensive system of irrigation.

The time required for surveying and locating this Fort Shaw ditch was almost as great as that for constructing the ditch itself. The vast region lying immediately around Fort Shaw and north, east, and south of it comprises thousands of acres of rich soil, needing only water to convert it into fine agricultural land. Streams are numerous and the supply of water ample. All that is needed is to conduct the water to the right places, and this can be done only by extensive and accurate surveys, the definite location of canals, and the construction of these and minor ditches to conduct the water onto the land. What is true of this particular region is true of a vast territory extending 18 or 20 degrees north and south, and 12° or 15 degrees east and west. Within these limits there are thousands upon thousands of acres which, without water artificially supplied, can never be used for agriculture, but with it can be made to produce the finest crops of all kinds. Land in this country is becoming rapidly more and more valuable, and more and more people

yearly require it for subsistence. This land, now useless except for scant pasturage, will be an absolute necessity in the near future, and must be made available.

Whatever difference of opinion there may be regarding the constitutional power of the Government to go to work digging canals, there can, I think, be none with reference to its power to make surveys of its own land and mark out where its citizens of the future can most advantageously place canals for conducting upon its lands what alone can make them of value as food-producers.

MEMORANDUM RELATING TO EASTERN OREGON.

Oregon, Washington, and Idaho have a good supply of water in the form of rain-fall. Most of this water falls during the fall, winter, and spring, and during the summer months there is generally a time of extreme dryness, in most parts east of the Cascade Mountains no rain falling for two or three months. Crops having deep roots do very well in most parts of this area; of course there are seasons when one crop or another fails or is extremely poor. This is not always due entirely to droughts, but may occur from want of knowledge or care in planting and cultivating; particularly is this the case with farmers coming from parts of the country where moister summers prevail.

Irrigation by private parties or companies has been successfully tried in a number of valleys, viz: The Klamath River Valley, both in Oregon and Northern California; the Boise River Valley, Idaho; the Snake River Valley, Washington and Idaho; the Colville River Valley, Washington; and, I understand, in the Rogue River Valley, Oregon.

The rivers of this region are large and would furnish enough water to supply systems of irrigation ditches which could be supplemented by storage reservoirs if necessary, or when the demands increase.

The region around Walla Walla (the Walla Walla wheat country) is a rich and productive country, and north of this is the area called the Great Plains of the Columbia, which, although not so well known, is a promising country. Both these regions are poorly supplied with water, at least during the summer months. The topography of this section is so imperfectly known that it is impossible to determine, without surveys, the practicability of irrigating by ditches or whether it would be necessary and practicable to make use of reservoirs. There is reason to believe that a sufficient supply of water would make this section a very fine agricultural country.

The Snake River above Lewiston has falls and rapids, and thus may afford an opportunity of running irrigation ditches to the lower lands below.

EXTRACT FROM AN ARTICLE BY GENERAL JOHN GIBBON ON THE NECESSITIES OF IRRIGATING PUBLIC LANDS, PUBLISHED IN THE OREGONIAN, 1887.

In the open beyond the mouth of the Port Neuf Cañon, at the junction of the Oregon Short Line and the Utah Northern (a narrow gauge extending away up into Montana), stands the little town of Pocatello, and 25 miles beyond we cross Snake River and catch a moonlight view of the American Falls, and then roll all that night and half the next day through the dusty, sage-brush desert of the Snake River Valley. For miles upon miles nothing is to be seen but the dry, dusty ground, in places alkaline, and the monotonous scraggy sage-brush. Here and there, where water can be had, the green fields and fences of settlers demonstrate the good quality of the soil and what could be done with it if only water could be placed upon it. The good quality of the soil is already shown by the growth of sage-brush, always a sure indication of richness. This sage-brush is a peculiar plant, and is found growing in places where scarcely anything else will grow under the same circumstances. Nature, however, provides it with the means of obtaining the requisite moisture not possessed by many other plants. It possesses a tap-root whose length seems to depend entirely upon the needs of the plant. I have seen in the Yellowstone Valley, where the bank has caved in, these tap-roots left exposed and running down 10, 12, and 15 feet. The sage-brush will not grow upon poor soil; hence the richness of most of this vast Snake River bottom is demonstrated. It needs only water to enable it to blossom as the rose and produce the finest crops of grain, for sage-brush land produces the best of wheat.

Already private companies have been organized for the construction of irrigating ditches in some portions of this vast valley, but now that our increasing population is calling for more land, a more extended and thorough system of irrigation should be instituted, looking forward to the time when every acre of the public land which can be, should be, made to produce crops of food. Such an extended and general system is entirely beyond both the means and foresight of private corporations. Be-

sides the great valley of the Snake River there are immense tracts of country through out the Northwest which could be made productive simply by placing water upon them. Along the Upper Missouri and its tributaries, along the Platte and its branches, and near various other streams there is an immense amount of land which might by this means be cultivated. Much of this is known as "bench-land," and now lies entirely above any water supply by ordinary means. All of that immense region which lies south of the British line and north of the Missouri River west of Fort Benton is of this character and could be brought under cultivation by tapping the streams high up near the mountains, and, by skillful engineering, conducting them by canals to the high ground from which the water might be distributed systematically to the lower levels. Recurring again to the Snake River Valley, the higher tributaries of that stream should be tapped well up towards the mountains, and good-sized canals constructed to skillfully lead the waters to those positions where they would be most useful.

These canals would not only serve for irrigating purposes, but they could be usefully employed in floating down from the mountains the valuable timber which exists there in such vast quantities and placing it where it could be used for the benefit of mankind, rendering a more extensive net-work of railways less essential. For this extended system of irrigation there would be needed, besides the canals themselves, aqueducts for conducting the water across streams, gorges, etc., and sometimes, though not often, tunnels. As a preliminary step, therefore, extensive and accurate surveys should be made and the routes of the canals in the various valleys laid out just as the line of a railroad is designated. This part of the work should be done by the Government through its capable, skillful engineer corps, whether it ever constructs a canal or not. The routes of the various canals, their dimensions, probable cost, etc., could all thus be determined beforehand, just as was done in regard to the Pacific railroads.

But it would be a paying investment for the United States Government to go further and actually build these irrigating canals. To get its money back it need not even resort to the expedient of taxing the people either for using the canals or the water which they carry. Much of the land which such a system would render productive would never otherwise be bought or settled upon, and should the expense of the system justify it the price of the land thus brought under cultivation could be doubled just as is now done with land near railroads and much more appropriately with canal lands, since these would be directly benefited by the canals. Besides this, another consideration should be taken into account. The Government is now spending vast sums every year to improve the navigation of our great rivers. They dredge out here, cut away there, and build dams and breakwaters in other places to guard against the action of floods in high-water seasons, and at this very time we are constructing at the headwaters of the Mississippi vast dams to hold and store up the waters accumulating in the wet season to be used in the dry, to decrease the amount of water for navigation purposes during one period and increase it at another. Man's whole effort is directed towards getting under his control, as far as possible, the forces of nature. He will be assisted in this by the system of canals which I propose.

When the snows of winter commence to melt in the mountains in the spring and to swell the streams of the lower country by their floods, a considerable portion of this water will be deflected from the river beds and led to flow quietly and peacefully to fructify the fields of man's industry in place of coming in floods to destroy them and other property.

But here I am dreaming again, not in retrospect but prospectively, and all because I prefer to think of this great Snake River Valley as a blooming, productive region filled with green farms and orchards to having it as it is, a vast, dusty wilderness, where as we whirl through it our eyes, mouth, ears, and hair are filled with the palpable dust in which our noses detect the odor of alkali.

The work referred to must ultimately be done, for the time will soon come when we can not afford to allow all this fine land to remain idle. But it is now well worth the attention of the Government, whilst most of it to which the system is applicable is still under Territorial government and the settling up of the desert places can be hastened. Experience demonstrates that as a country is settled up and subjected to cultivation a remarkable and gradual change takes place in the climatic conditions. Regions in which, in a state of wildness, scarcely enough moisture was deposited to support a scanty growth of grass, under cultivation are provided, as by a miracle, with rains sufficient for all kinds of crops, until the process of irrigation, at first a necessity, becomes no longer essential.

IRRIGATION INCORPORATIONS IN WASHINGTON.

The following list was furnished the committee by the Secretary of Washington Territory.

Atalman Irrigating Ditch Company, Yakima; capital stock, \$6,000; J. W. Morris.

son, J. S. Bounds, and J. H. Miller, trustees, residing at Yakima City, Yakima County.

Ahtanum and Wide Hollow Ditch Company; capital stock, \$600; trustees, H. D. Winchester, A. Percival, and S. J. Shaw, Wide Hollow, Yakima County.

Brock Creek Flume Canal and Irrigating Company; capital stock, \$2,000; trustees, Amos Underwood, Edward Underwood, and Jefferson Underwood, county of Skamania.

Eureka Water Supply and Irrigating Company; capital stock, \$10,000; trustees, F. F. Adams, W. C. Painter, J. C. Isaacs, George W. Bradbury, and T. M. Speed, all of Walla Walla, Walla Walla County.

Moxsee Ditch Company, Yakima, Yakima County; capital stock, \$1,200, increased to \$10,000; trustees, P. S. Burke, C. P. Fowler, and W. F. Jones, all in Moxsee Valley, Yakima County.

Natchez and Cowichie Ditch Company; capital stock, \$1,000.

Oriental Ditch Company; capital stock, \$600; place of business, Ellensburg, Yakima County; trustees, David Ford, A. Wilty, and T. D. Irvin.

Union Ditch Association, Yakima County; capital stock, \$500; trustees, Frank Parker, J. T. Simmons, W. D. Beck, J. M. Emery, and G. W. Goodwin.

West Side Ditch Company; capital stock, \$5,000; trustees, G. W. Goodwin, E. R. Welch, J. K. Millican, and Martin Schieher, all of Yakima, Yakima County.

Yakima Valley Water Association, Yakima, Yakima County; capital stock, \$200,000; trustees, R. B. Kinner, C. M. Holton, Thomas McAuslan, T. B. Nelson, Howard C. Watters, J. M. Adams.

Yakima Farm and Water Company; capital stock, \$50,000; trustees, George Kinnear, Baily Gatzert, J. R. Lewis, W. R. Brambley, and J. T. McKnight, all of Seattle, Wash.

Broad-Gauge Ditch Company; capital stock, \$4,000; trustees, Joseph Bartholet, Mariah L. Ferguson, and Charles F. Navarre, all of North Yakima, Yakima County.

Coleman Creek Reservoir and Irrigation Company, capital stock, \$10,000; trustees, M. H. Peterson, Tillman Howser, and Harvey Heese, all of Ellensburg.

Iowa Flat Ditch Company Yakima County; capital stock, \$1,500; trustees, W. R. Taylor, H. S. Maning, and V. Ritter.

Last Chance Ditch Company, Moxsee Valley, Yakima County; capital stock, \$2,500; trustees, C. V. Fowler, Z. T. Fowler, and T. H. Fowler, all of North Yakima.

Manastask Water Ditch Company; capital stock, \$1,500; trustees, Samuel Packwood, J. W. Shelton, and A. M. Stevens, all of West Kittitas, Wash.

The Watt Ditch Company, Kittitas County; capital stock, \$2,000; trustees, J. W. Brooks, T. G. McDowell, W. H. Beck, West Kittitas Valley, Kittitas County.

Yakima Irrigating Land and Chilling Company; capital stock, \$100,000; trustees, D. M. Drumletter, J. M. Allen, Alvooh Churchill, J. B. Pavis, and Edward Whitson.

Fowler Ditch Company; capital stock, \$7,500; Moxsee, Yakima County; trustees, Henry B. Selender, C. O. Fowler, and T. H. Fowler.

Natchez and Cowichie Ditch Company, North Yakima stock, \$8,000; trustees, J. F. Stewart and Paul Yola.

Schanno Ditch Company; capital stock, \$12,800; trustees, M. Bartholet, S. Lawton, S. O. Mosford; North Yakima.

Wanatchee Ditch Company; capital stock, \$50,000; trustees, Zadock A. Lawham, Joseph T. Miller, and George W. Blair, all of Wanatchee, Kittitas County.

Valley Land and Irrigating Company; capital stock, \$500,000; North Yakima, place of business; trustees, Chester A. Cowgdon and Henry P. Barborn, of St. Paul, Minn., and Roland B. Kine, of North Yakima, and Frank A. Sears and Theodore C. Sears, of Tacoma.

Yakima Irrigating and Improvement Company; capital stock, \$400,000; trustees, J. W. Dudley, Hurbert S. Hudson, A. A. Knight, all of Tacoma; Hector Campbell, Niagara Falls, Niagara County, N. Y.; Frank A. Dudley, Niagara Falls, Niagara County, N. Y.

West Side Irrigating Company; capital stock, \$10,000; J. R. Thorp, S. R. Giddis, W. A. Steavens, J. N. Burch, E. S. Coleman, Ellensburg, all trustees.

Old Union Ditch Company; capital stock, \$2,600; trustees, Joseph Strout, W. L. Splawn, James Foster, J. H. Hathway, James T. Simmons, all of North Yakima.

Settlers' Ditch Company, Kittitas County; capital stock, \$12,000; trustees, Edward A. Haley, Toleman Tripp, and George W. Blair, of Ellensburg, Wash.

Tenemass Ditch Company; capital stock, \$2,000; trustees, James L. Bates, S. T. Packwood, and J. H. Stevens, of West Kittitas Valley, Yakima County.

Tenaway Ditch Company; capital stock, \$50,000; trustees, T. H. Wilkins, Thomas T. Wilson, W. J. McAusland, R. P. Lijopern, J. D. Olmstead, Ellensburg.

Wenas Ditch Company, Yakima County; capital stock, \$1,000; trustees, Jacob Rogers, T. Manning, and J. McGlothlan.

Adjourned.

OREGON DIVISION.

ON TRAIN AT THE DALLES, OREGON,

August 15, 1889.

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman), Jones, and Reagan; also Director Powell.

STATEMENT OF T. S. LANG, OF THE DALLES.

The CHAIRMAN. How long have you resided at The Dalles?

Mr. LANG. Sixteen years.

The CHAIRMAN. Will you explain to the committee the condition of the country immediately east of the mountains, and make such suggestions about irrigation that may occur to you?

Mr. LANG (indicating on a map). This is the line of mountains along through here. That is Mount Hood. I have walked over all that country and followed the water-courses, and they follow Mount Hood to the south and Mount Jefferson. All these turn their waters into the Des Chutes River and empty into the Columbia about 12 miles above The Dalles. That river never rises nor falls over 7 feet, and has very warm water, no matter how cold the winter may be.

The CHAIRMAN. What is the name of the other river?

Mr. LANG. The John Day's River.

The CHAIRMAN. That is near what place?

Mr. LANG. Near Blalocks, about 35 miles above The Dalles. These rivers run parallel to each other, and there is an area of country between them averaging 40 miles wide. That country has a deep soil. I have gone down to the subsoil on every half mile for 100 miles, and it is from 2½ to 14 feet deep before you come to the dead soil. Any of the soil which is turned up here on these farms will bear good grain. It simply requires water to make it reliable. Between the two rivers it is a perfectly splendid soil. You will find deposits of alluvial soil on this portion [indicating]; and on the west side of the Des Chutes River there are a few places, high plains, that are watered by snow melting—up along through there [indicating].

The CHAIRMAN. Is that a reservation [indicating]?

Mr. LANG. Yes; it is the Warm Spring Reservation, and here [indicating] are the high plains.

The CHAIRMAN. How is it to the north of the reservation and between it and the Columbia River?

Mr. LANG. There is a whole township there—22,500 acres—that grows very good crops without irrigation. The land is very good between the Des Chutes and the John Day's Rivers. There [indicating] the soil is very rich, and the water for irrigation can be taken from the high streams which run out of the mountains. White River runs out from a solid cliff nearly 300 feet high, and the water is about 2½ feet deep, and there will be an inch of ashes in it coming out of the mountains.

The CHAIRMAN. How far back from the river going south and between the two rivers does this land extend?

Mr. LANG. About 80 or 90 miles.

The CHAIRMAN. Have you been further south in Oregon?

Mr. LANG. No; I am not familiar with that. I have been one trip down to the California State line north of Klamath Lake. That land grows very excellent grass and is a good grazing country.

The CHAIRMAN. How is it supplied with water?

Mr. LANG. Portions of it have plenty of water, and portions have not. Take the portion on this meridian, around through Klamath, and there is plenty of water. About midway between the Columbia River and the California State line it is deficient of water, and that country would be benefited very materially by irrigation.

The CHAIRMAN. Is it a warm country, so that irrigation would be beneficial to crops?

Mr. LANG. There is no question about that.

The CHAIRMAN. Have you examined it with the view of ascertaining whether water could be gotten to it?

Mr. LANG. No; I have not examined it with that view.

The CHAIRMAN. Going east of the John Day's River, what is the character of the country? Are there other streams making into the Columbia along there?

Mr. LANG. Yes; the Umatilla.

The CHAIRMAN. How far is that from the John Day's River?

Mr. LANG. About 45 miles.

The CHAIRMAN. What country does the Umatilla River drain?

Mr. LANG. Umatilla and Gillam Counties would be very largely benefited by irrigation.

The CHAIRMAN. How is that country in the direction of requiring irrigation?

Mr. LANG. It would require irrigation to be thoroughly successful each year.

The CHAIRMAN. Do they raise crops there without irrigation?

Mr. LANG. In portions of Umatilla County they raise crops; but they have not sufficient water to keep it up.

The CHAIRMAN. Are the low bottom-lands irrigated by seepage from the river?

Mr. LANG. No; some of them are close up to the timber, where they get the benefit of the timber which sustains the springs.

The CHAIRMAN. What will be the effect in that country, of cutting timber off the land?

Mr. LANG. It would be disastrous to that country, just as it would be here, where they have been cutting timber and burning it up.

The CHAIRMAN. Do they burn it up pretty rapidly?

Mr. LANG. Yes; the people go into it and set off their fires.

The CHAIRMAN. Have you any suggestions to make on the subject of timber in eastern Oregon?

Mr. LANG. I do not know what you can do except to make local laws governing the people and preventing them from going into the woods and building fires.

Adjourned.

ON TRAIN, BAKER CITY, OREGON.

August 16, 1889.

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman), Jones, Reagan; also Director Powell.

STATEMENT OF MR. C. M. FOSTER, OF BAKER CITY.

The CHAIRMAN. How long have you resided in Baker City?

Mr. FOSTER. Twenty-seven years.

The CHAIRMAN. Does the country here require irrigation to produce all around crops?

Mr. FOSTER. It does.

The CHAIRMAN. What is the extent of the arable land in this valley?

Mr. FOSTER. About nine townships.

The CHAIRMAN. What stream runs through it?

Mr. FOSTER. Powder River.

The CHAIRMAN. Is there sufficient water in the Powder River to irrigate all the land in those nine townships?

Mr. FOSTER. No.

The CHAIRMAN. Is there any other water supply?

Mr. FOSTER. Only small mountain streams on the west side of the valley.

The CHAIRMAN. Could the amount of water be increased by storage?

Mr. FOSTER. It could be.

The CHAIRMAN. Does a large amount of water run to waste?

Mr. FOSTER. It does in the early part of the season.

The CHAIRMAN. Do you utilize the small streams in the valley?

Mr. FOSTER. Yes; all of them.

The CHAIRMAN. Has there been any effort to increase the quantity of water in those small streams?

Mr. FOSTER. No.

The CHAIRMAN. You have no storage reservoirs?

Mr. FOSTER. No.

The CHAIRMAN. Has your attention been called to that subject?

Mr. FOSTER. We have reservoirs for mining purposes, but not for farming purposes.

The CHAIRMAN. You say there is a large amount of water that runs to waste?

Mr. FOSTER. Yes.

The CHAIRMAN. If it were all stored would it irrigate the whole valley?

Mr. FOSTER. Yes.

The CHAIRMAN. Are there any opportunities in the mountains for building reservoirs to hold back portions of the water? Are you familiar with the mountains?

Mr. FOSTER. Yes.

The CHAIRMAN. Are there places in the mountains where you could construct reservoirs?

Mr. FOSTER. Yes; there are places for storage-reservoirs in the valley that would increase the utility of the water very much.

The CHAIRMAN. You have engaged in storing water for mining purposes?

Mr. FOSTER. Yes.

The CHAIRMAN. That has to be stored at a very high altitude?

Mr. FOSTER. Yes.

The CHAIRMAN. Are you familiar with the sources of the Powder River?

Mr. FOSTER. Yes.

The CHAIRMAN. What is the chance for storing water there?

Mr. FOSTER. Very good.

The CHAIRMAN. What advantage would it be to have the Powder River and all the little streams that flow into it surveyed, and the places indicated as reservoir sites reserved, with estimates of the cost of the land to be covered? Would that have any effect in enabling settlers to make homes without any other expenditure of money?

Mr. FOSTER. Not in the Powder River Valley. The Powder River Valley is all claimed and bought up already. Of course, what you intimate would help to increase the water supply. But for new-comers there would be no land; it would be only on the side of dry hills.

The CHAIRMAN. Are there small hills and creeks coming down them?

Mr. FOSTER. Yes.

The CHAIRMAN. Would there be much of that land?

Mr. FOSTER. Thousands of acres of it.

The CHAIRMAN. Is it good land?

Mr. FOSTER. Good soil; all it needs is water.

The CHAIRMAN. If it could be ascertained that water could be stored there to irrigate the land would other settlers go there?

Mr. FOSTER. Yes.

The CHAIRMAN. The Government has started in to survey the arid land with a view of setting apart reservoir sites, designating the lines of ditches, and estimating the cost of constructing them. The problem of taking out the large rivers we have not yet reached. We want to know what effect it would have in the way of settling up the public lands—what advantage would such data be to settlers?

Mr. FOSTER. You will find more unoccupied lands over in the southern part of the county than in the northern part. There are thousands of acres there to be reclaimed.

The CHAIRMAN. What is the difficulty about reclaiming it now?

Mr. FOSTER. None.

The CHAIRMAN. Do the people not know how?

Mr. FOSTER. They know how, but it takes money, a great deal of money—more money than most persons are aware of.

The CHAIRMAN. Then surveys would not help the people?

Mr. FOSTER. No. But those canals would help them.

The CHAIRMAN. That is, the main valley. Are you aware that you would have to construct canals before you could do anything?

Mr. FOSTER. Yes, it would require canals all around to get to these places. It would take miles of ditches.

The CHAIRMAN. During the winter is there snow in the mountain?

Mr. FOSTER. Yes. But here to the westward of Powder River Valley there are low hills. The snow lies there, but does not make much water.

The CHAIRMAN. What does irrigation do in the way of producing crops in the Powder River Valley?

Mr. FOSTER. It produces a good crop where otherwise it would not give good crops.

The CHAIRMAN. State what kind of crops it produces?

Mr. FOSTER. It will produce a crop of wheat 20 to 25 bushels to the acre, where you would not get any without irrigation.

The CHAIRMAN. How as to alfalfa?

Mr. FOSTER. Three crops, where without it you would not get one.

The CHAIRMAN. How much alfalfa would you raise in the year?

Mr. FOSTER. Eight to 9 tons to the acre if you have water; if not, you would get about three.

The CHAIRMAN. You think the whole area could be irrigated with a sufficient expenditure of money?

Mr. FOSTER. Yes.

The CHAIRMAN. You are an engineer?

Mr. FOSTER. I am.

The CHAIRMAN. Have you ever made an estimate of the cost per acre for putting water onto the land?

Mr. FOSTER. Not about Powder River Valley.

The CHAIRMAN. How much of the land here is irrigated?

Mr. FOSTER. It is all irrigated more or less. No crop is certain without irrigation.

Senator JONES. How is this Powder River Valley occupied?

Mr. FOSTER. All the land is bought up and owned by private parties.

Senator JONES. Are the holdings in large tracts, or do they vary?

Mr. FOSTER. They vary from 16,000 acres, held by the railroad company, down to 160 acres, held by individuals. Most of it is in small holdings.

Senator JONES. But is the land generally used? Is it farmed, stock raised on it, or is it lying idle?

Mr. FOSTER. About half of it is lying idle—held for speculation.

Senator JONES. Can you give any reason why the people are holding this land for speculation when it is not improved? Why do they not bring water onto it?

Mr. FOSTER. The railroad company owns 16,000 acres, and it will not make any effort to bring water onto this land. It will sell the land for \$4 or \$5 an acre.

Senator JONES. Do other land-owners make any effort to put water onto their land.

Mr. FOSTER. No, except the farmers themselves.

Senator JONES. They hold land in small quantities?

Mr. FOSTER. Yes; 160 acres.

STATEMENT OF C. HINDMAN, OF BAKER CITY.

The CHAIRMAN. What is your occupation?

Mr. HINDMAN. Stock-raising.

The CHAIRMAN. Have you examined the subject of irrigation?

Mr. HINDMAN. Yes.

The CHAIRMAN. What effect has irrigation upon the production of crops in the valley?

Mr. HINDMAN. It washes the alkali out of the ground and fertilizes it so that it will improve vegetation.

The CHAIRMAN. Can you produce crops in the valley without irrigation?

Mr. HINDMAN. No, you can not.

The CHAIRMAN. Do you farm by irrigation?

Mr. HINDMAN. I do.

The CHAIRMAN. What kind of crops do you raise?

Mr. HINDMAN. I am not what you would call a farmer; my principal business is stock-growing; but I raise some grain. Oats will go as high as 45 bushels to the acre and wheat 30 bushels to the acre.

The CHAIRMAN. With irrigation?

Mr. HINDMAN. Yes.

Senator JONES. How much will the land produce without irrigation ?

Mr. HINDMAN. Not more than 10 bushels in some localities.

The CHAIRMAN. Do you raise fruits in the valley ?

Mr. HINDMAN. Yes.

The CHAIRMAN. All kinds ?

Mr. HINDMAN. We raise apples, pears, plums, and peaches. They all do well, and so do the small fruits.

The CHAIRMAN. You say you are a stockman. Have you traveled through the mountains and noticed the sources of the river ?

Mr. HINDMAN. I have.

The CHAIRMAN. What proportion of the water runs to waste in high tide—in flood time—water that is not used at all ?

Mr. HINDMAN. I think three-fourths of the water from the mountains runs to waste during the season.

The CHAIRMAN. Have you ever taken into consideration the subject of utilizing that by storing it in reservoirs ?

Mr. HINDMAN. I have given it a good deal of thought.

The CHAIRMAN. What are the opportunities for doing that ?

Mr. HINDMAN. I think they are very good for agricultural purposes. The cañons go well down into the valleys where you can build your reservoirs, while for mining purposes you have to go up high. You can store the water down in these deep cañons before you come to the river.

The CHAIRMAN. Are there small streams and places about the valley where there are public lands and where water could be stored for the use of small farms ?

Mr. HINDMAN. At the foot-hills east of the valley there are plains and some places where in the spring there is a good deal of water from the melting snow. There are three channels there, and they are very easy places to build these reservoirs.

The CHAIRMAN. Could that be done without a large expenditure of money ?

Mr. HINDMAN. Yes. There are two Powder Rivers that run through the valley, one east and the other west; one south of the mountains and one north. At the south of the mountains it forms what is called the Snake and makes a large valley there, and before it strikes this valley it comes near these cañons. There you could build a reservoir to hold an immense amount of water, sufficient to irrigate this land.

The CHAIRMAN. It is good land ?

Mr. HINDMAN. It would be if it were irrigated.

The CHAIRMAN. Is that private land ?

Mr. HINDMAN. That is public land, not entered, because valueless for want of irrigation.

The CHAIRMAN. How did the railroad company become possessed of that land ? There was no grant to it.

Mr. HINDMAN. No, they bought it. It was State land, State donation. Senator JONES. How did the State own it ?

Mr. HINDMAN. It was donated to the State, I suppose.

The CHAIRMAN. Do you know any other fact you would like to state ?

Mr. HINDMAN. I think it would almost double our population if those reservoirs were built for agricultural purposes.

STATEMENT OF L. D. HAINES, OF BAKER CITY.

The CHAIRMAN. How long have you resided in Baker City?

Mr. HAINES. About twenty years.

The CHAIRMAN. What is your occupation?

Mr. HAINES. Lawyer and rancher.

The CHAIRMAN. Have you traveled over the country so that you are familiar with its topography and its water supply?

Mr. HAINES. Yes.

The CHAIRMAN. Have you practiced irrigation?

Mr. HAINES. Yes, I have irrigated for the last twenty-odd years.

The CHAIRMAN. What effect does irrigation have upon agriculture?

Mr. HAINES. It adds to the fertility of the land and increases the crop 50 per cent.

The CHAIRMAN. Can you raise all kinds of crops in the valley without irrigation?

Mr. HAINES. No.

The CHAIRMAN. What kind can you raise?

Mr. HAINES. Grain, wheat, barley, oats, rye, and some alfalfa. It is not so good for alfalfa as it is down on the Snake River.

The CHAIRMAN. And you could raise some without irrigation?

Mr. HAINES. Yes.

The CHAIRMAN. Could you raise alfalfa without irrigation?

Mr. HAINES. Yes, by putting it in in the fall. But it does not do well.

The CHAIRMAN. When you do not irrigate it the gophers spoil it?

Mr. HAINES. Gophers and mice work up the soil and spoil the alfalfa and timothy meadows. If you do not irrigate they will throw the dirt up, and you can not use the mower.

The CHAIRMAN. The best of your land under irrigation would improve 50 per cent.?

Mr. HAINES. About.

The CHAIRMAN. How about all-around crops?

Mr. HAINES. All-around crops the same way, especially in Malheur and Harney Counties, to the south.

The CHAIRMAN. How are the counties to the south?

Mr. HAINES. They have not much. The water rises there in the mountains and sinks like it does in the Umatilla Valley.

The CHAIRMAN. The streams, as they get down to the valley, sink?

Mr. HAINES. Yes. By storing up water in the mountains and putting in ditches they could use a good deal of it in irrigating the land and producing crops. Where streams are now they go down and evaporate. They take the water out in a good many places in these lakes, ponds, and sinks.

The CHAIRMAN. Would Government surveys help in those valleys to the south of this of which you speak?

Mr. HAINES. They would help in this respect—by finding out how much water there was and introducing some system for utilizing it. If farmers are going to take up water-rights for their whole land, in ten or fifteen years one farmer will get four times as much as he needs, and will want to sell to his neighbors.

The CHAIRMAN. As it is, there is not a fair distribution?

Mr. HAINES. No.

The CHAIRMAN. And the water is wasted?

Mr. HAINES. If not wasted, it is a matter of speculation. A man

takes all the water he can get. There is a good deal of water there if the land were taken up where the water comes out of the mountains, and if it were stored in reservoirs it could be let on the land which now is not taken—land belonging to the Government of the United States.

The CHAIRMAN. If the facts were made plain by maps, would it induce emigrants to settle there?

Mr. HAINES. Yes; the lands are good enough, but they can not use the water. Now, when an emigrant comes along, not having money enough to make a ditch and construct a reservoir to store the water, he goes farther down to hunt a ranch. There is a good deal of land in these valleys not occupied on that account.

The CHAIRMAN. Are there many places where the settlers could combine and take up water?

Mr. HAINES. Yes; they do it up on the Owyhee River.

STATEMENT OF J. W. STURGILL, OF BAKER CITY.

The CHAIRMAN. How long have you resided in Baker City?

Mr. STURGILL. Twenty-five years.

The CHAIRMAN. Are you familiar with the topography of that country?

Mr. STURGILL. Yes.

The CHAIRMAN. And the counties south, Malheur and Harney Counties, have you ever been over the whole of that country?

Mr. STURGILL. Yes.

The CHAIRMAN. Who occupies those south valleys?

Mr. STURGILL. Principally stockmen.

The CHAIRMAN. Do they cultivate the soil?

Mr. STURGILL. They cultivate it in this way, they put it down in hay.

The CHAIRMAN. Do they irrigate?

Mr. STURGILL. Yes; they can produce no crops without irrigation.

The CHAIRMAN. To what extent do they irrigate?

Mr. STURGILL. Not to any considerable extent.

The CHAIRMAN. Do they make any efforts to increase the water supply?

Mr. STURGILL. No.

The CHAIRMAN. Are there any public lands in that locality?

Mr. STURGILL. Yes, plenty of them.

The CHAIRMAN. Are there public lands that could be taken up by a combination of settlers?

Mr. STURGILL. Yes, large bodies of them.

The CHAIRMAN. Is it a good climate?

Mr. STURGILL. Yes; a fine climate and a productive soil.

The CHAIRMAN. I understand from these other gentlemen that the valley part of Powder River is all private land.

Mr. STURGILL. It is.

The CHAIRMAN. How are the foot-hills on either side of Powder River Valley?

Mr. STURGILL. There is considerable vacant land there.

The CHAIRMAN. Is there any chance to irrigate it?

Mr. STURGILL. Only by storage reservoirs.

The CHAIRMAN. Is it good land?

Mr. STURGILL. Yes; very good land. The best in the valley.

The CHAIRMAN. How does that land compare with the valley itself, as a quantity?

Mr. STURGILL. I can not tell that.

The CHAIRMAN. What do you say as to the effects of irrigation, as far as you have observed them?

Mr. STURGILL. Without irrigation we could raise nothing. There have been a few seasons in the last twenty-five years in which crops might have been produced without irrigation, but they have been very few.

The CHAIRMAN. With irrigation, what kind of crops do you produce here?

Mr. STURGILL. Grain and garden crops.

The CHAIRMAN. State whether the yield is large or small.

Mr. STURGILL. The yield is large. We get 25 to 50 bushels to the acre; the same of oats; two tons and a half of hay, and 6 or 8 tons of alfalfa.

The following was received from the secretary of Washington Territory and ordered filed, being a provision of the newly framed State constitution:

ARTICLE XXI.—WATER AND WATER RIGHTS.

Section 1. The use of the waters of this state for irrigation, mining and manufacturing purposes shall be deemed a public use.

Adjourned.

IDAHO DIVISION.

ON TRAIN AT PALMER, IDAHO,
August 16, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), Jones, and Reagan; also Director Powell.

STATEMENT OF HOWARD SEBREE, OF CALDWELL.

The CHAIRMAN. Are you engaged in farming by means of irrigation?

Mr. SEBREE. Yes.

The CHAIRMAN. What water have you turned and what land have you irrigated? Give your experience.

Mr. SEBREE. I have within the last three years built an irrigating ditch 23 miles in length, and diverted the water from the Bois  River, at a point in Caldwell, carrying it in a southeasterly direction to the mouth of the Bois , then turning down the Snake. The ditch is 20 feet on the bottom and 30 feet on the top, at the head-gate where we divert the water, running about half the distance, then reducing to 12 and 15 feet the balance of the distance.

The CHAIRMAN. How much land does that ditch irrigate?

Mr. SEBREE. About 25,000 acres.

Senator JONES. Is that the full capacity of the ditch?

Mr. SEBREE. Yes; but of course we can make it greater.

The CHAIRMAN. What was the cost of the ditch?

Mr. SEBREE. Sixty-five thousand dollars.

The CHAIRMAN. How much would it cost per acre, including the lateral ditches, to put it on the land?

Mr. SEBREE. The cost of the lateral ditches is very trifling—about 25 cents an acre.

The CHAIRMAN. You have raised crops under that ditch by means of irrigation?

Mr. SEBREE. Yes; up above this bench-land where you are traveling, 2 miles back from this point (the railroad), is the line of the irrigating ditch. That land between us and the big ditch is taken up and the farmers are clearing away the brush and raising crops.

The CHAIRMAN. What is the result where you have irrigated?

Mr. SEBREE. This year there have been already 4 tons of alfalfa taken off per acre.

Senator JONES. And from land that would have been worthless but for water?

Mr. SEBREE. Yes; entirely so. I have cut the second crop from my land. I have 640 acres, and all of it fenced. There are 320 acres of it

cleared of sage-brush; 200 acres ditched, and in alfalfa, of which we are cutting the second crop now.

The CHAIRMAN. The stand is how old?

Mr. SEBREE. The stand we are now cutting is six weeks old.

The CHAIRMAN. From the time it was planted?

Mr. SEBREE. Yes; April and May of this year.

The CHAIRMAN. And you have cut that much?

Mr. SEBREE. Yes; and we get about 6 to 8 tons to the acre where we get a good stand. But 4 tons to the acre I can get off the entire section. The last cutting we made was when it would stool out.

The CHAIRMAN. How old was the alfalfa?

Mr. SEBREE. We planted in April, May, and June of this year.

The CHAIRMAN. What is a good yield during the whole year for alfalfa?

Mr. SEBREE. Taking the whole field of 200 acres, it will average 4 tons to the acre. You will get a little less in some places, but it will average 4 tons. Six tons are very common—2 tons each cutting.

The CHAIRMAN. Do you raise wheat?

Mr. SEBREE. Yes.

The CHAIRMAN. How is that?

Mr. SEBREE. Good; an average crop being 40 bushels to the acre.

The CHAIRMAN. How about barley?

Mr. SEBREE. Sixty bushels to the acre.

The CHAIRMAN. Do you raise potatoes here?

Mr. SEBREE. Yes.

The CHAIRMAN. What would be a good crop of potatoes?

Mr. SEBREE. An average crop would run from 300 to 400 bushels to the acre.

The CHAIRMAN. Do you raise fruits?

Mr. SEBREE. Yes; and they are good.

The CHAIRMAN. What character of fruits do you raise?

Mr. SEBREE. Apples, peaches, plums, pears, and all kinds of small fruits—strawberries, blackberries, currants, gooseberries.

The CHAIRMAN. Do you raise grapes?

Mr. SEBREE. Yes; a splendid quality of grapes.

Senator JONES. Are the land-owners along the line of this ditch the owners of the ditch?

Mr. SEBREE. The largest bodies of land are held by owners along the line of the ditch.

The CHAIRMAN. Have they an interest in the ditch?

Mr. SEBREE. We lend the water to the people. They take up the land in homestead, pre-emption, and timber-culture claims, and make homes, and then we sell them the water annually for so much—\$1 an acre each per year.

Senator JONES. Can you charge the people any price you may please for the use of the water?

Mr. SEBREE. There is no price fixed by law; custom regulates it.

Senator JONES. You can charge them only a reasonable price. But suppose a company occupying the same position that you do should not be reasonable, would they not have the people at a disadvantage?

Mr. SEBREE. No; that would not be the case. I have lived in this country where irrigation has been entirely used, and there never has been any extortion. When you get a reasonable profit on your investment the law stops you. That has been the case in Colorado.

Senator JONES. Is there a local statute here which will protect the people in their rights?

Mr. SEBREE. No; I think not; not to my knowledge.

Senator JONES. How much water do you want on your land—how much in depth?

Mr. SEBREE. A half inch to the acre is what we are using.

Senator JONES. What do you mean by an inch?

Mr. SEBREE. An inch is a miner's inch under a 4-inch pressure.

Senator REAGAN. How long has that to flow?

Mr. SEBREE. That is continuous only when we have to close the head-gates for causes, for repairs, etc.; and in winter.

The CHAIRMAN. Otherwise it runs the year round?

Mr. SEBREE. Yes.

The CHAIRMAN. Do you irrigate in the winter and fall?

Mr. SEBREE. We have good winters in this valley. I have plowed all winter—every month in the year.

The CHAIRMAN. What season of the year do you irrigate?

Mr. SEBREE. May, June, July, and August.

STATEMENT OF D. W. BUTLER, INDIAN AGENT AT WARM SPRING AGENCY, OREGON.

My views are mostly arrived at by comparing the places that I have seen irrigated. There is an abundance of water available. I assisted in the survey of a ditch a few years ago which is intended to supply the Oak Grove plains with water; the survey was made by John A. McQuinn, of Portland, Oregon, a practical surveyor and engineer, who estimated, if I remember right, the cost at \$900 per mile, and the length at 8 miles. The water, or stream at this place that can be used, is 25 feet wide and 1 foot deep, and this is a very low stage of water. I do not understand the rules of measuring water, but I am sure that there is an abundance for all purposes. Oak Grove plains are situated in the southern portion of Wasco County, Oregon, and in the following townships: Township 5 south, range 11 east; township 5 south, range 12 east; township 4 south, range 13 east; township 4 south, range 14 east; township 6 south, range 11 east; township 6 south, range 12 east; township 6 south, range 13 east; containing an area of about 100,000 acres. The next is a district lying on the opposite side of White River from the above described country, and in township 4 south, range 11, 12, and 13 east, and containing 40,000 or 50,000 acres of land, with a good portion being cultivated by a successful system of irrigation.

There is a large district of country lying on the east side of the Deschutes River and known as the Agency Plains, which are 6 miles wide and about 25 miles long, and water can be furnished by a ditch from the Deschutes River south of the second standard parallel and running north through township 12 south, 13 east; township 11 south, 13 east; township 10 south, range 13 east; township 9 south, range 13 east, and township 9 south, 14 east.

I deem it absolutely necessary, if the Warm Spring Indians are to become self-supporting, that the lands on this reservation should be made susceptible of cultivation through irrigation. I will give you the amount of land as near as possible by reference to the maps of survey: Township 7 south, range 11 east; township 8 south, range 11 east; township 8 south, range 12 east; township 9 south, range 12 east; township 9 south, range 12 east, containing near 100,000 acres, and lying in Wasco and Crook counties.

**STATEMENT OF THOMAS PRIESTLY, INDIAN AGENT AT YAKIMA
AGENCY, FORT SIMCOE, WASH.**

About all irrigation plans and practices as to reclaiming arid lands here have originated with, and have largely been controlled by, the Indian agents in charge of the reservation. From them the Indians have learned the value of irrigating their farms and hay lands. They display some engineering skill in such work, but tell me that they can not make the "water run up hill as some white men do." Their mode of irrigation is to dam the streams and cut ditches from such water supply to their farms. They generally club together and make a large ditch to or near the locality of their ranches, and the water supply is then divided equally between those who have constructed the ditch; each one then constructs a ditch from the main one to where he wants his water used, making lateral ditches through his field. The distance between these lateral ditches through their farms is governed by the nature of the soil and kind of crop. Gentle flooding of some lands is beneficial to some crops, while the same practice in others on different kinds of soil is almost certain destruction.

Some of the streams from which the Indians obtained water for irrigation have dried up much earlier than usual this season by reason of the unusual light fall of snow and rain in the mountains, their source of supply. The Indians who have depended on obtaining water from such streams will have no crops of grain and but little hay. In order to make these lands productive every year some system of saving the large surplus of water which flows through the reservation in winter and early spring will have to be adopted.

The rule I have adopted with these Indians as to distribution of the water supply is that of those constructing a ditch; the person at the lower end thereof shall not be deprived of his share of the water supply by reason of others locating above him; men who so locate can have water if they increase the supply by labor on such main ditch or dam to the extent of the amount used, or pay in labor by keeping ditch and dam in repair; if ditch contains enough water for use of all, a just proportion of constructing it.

**STATEMENT OF S. G. CARPENTER, CAPTAIN FOURTEENTH IN-
FANTRY, COMMANDING FORT KLAMATH, OREGON.**

Within the Klamath Basin east of the Cascade Mountains the aridity of the climate invites irrigation. The gradual but certain drying of the lakes has left much more area of open bottoms exposed than is now covered. These are fertile and becoming inhabited. These gentle slopes, meandered by numerous streams, together with the differences in level of the series of lakes, give peculiarly favorable opportunities for irrigation. On the Middle Klamath Lake, at Linkville, Oregon, an irrigating ditch leading from the upper lake now waters several thousand acres. It is estimated that when all ditches now under construction there are done about 45,000 acres will thus receive moisture.

Since the feeders to these lakes are mostly subterranean, debouching in full volume from the rim-rock about the lake beds, there is little opportunity for building increased storage for these waters. Indeed, so good are the natural adaptations within the Klamath River Basin for irrigation, that private enterprise can be depended on alone for this, I believe, without expenditure of any public moneys.

The peculiar topography, which permits the Deschutes River to drain all the streams coming from the eastern slopes of the Cascades to the north of the Klamath Basin in Oregon in a trough parallel and close to the foot-hills of the range, makes it doubtful if the Government will be ever called on to do any work worthy of it in this zone.

Committee adjourned to meet on call of chairman.

BOISÉ CITY, IDAHO, *August 17, 1889.*

The committee met pursuant to the call of the chairman.

Present, Messrs. Stewart (chairman), Jones, and Reagan; also Director Powell.

STATEMENT OF ALANSON SMITH, OF BOISÉ CITY.

Mr. Chairman and gentlemen, there is no question about an affirmative answer being proper in regard to the supply of water for the whole Territory, because it is undoubtedly full and complete in most of the Territory, especially this portion of it. It will require irrigation; but the sources of supply are abundant, and it is only a question in the way of finances to bring the water on to the land.

I have been through the Territory while acting as United States attorney for a period of nearly four years—have traveled from north to south, and have been over the mountains. Therefore, I can speak from personal observation and experience, and I desire to add my knowledge to that which will be communicated to you in a more direct way, and perhaps plainer form, in regard to the resources of this Territory. They are beyond those of any State or Territory in which I have lived, with the exception of California. I lived in that State for a long time, as Senator Stewart knows, and in Oregon and Nevada. For seventeen years I have lived in this Territory.

In regard to the water supply, the sources of that supply are the contiguous currents of the Arctic region with the Pacific currents, precipitating on our mountains with snows. Our rivers are always full, less this year than ever before that I know of for the last seventeen years. The only question about the use of water is the ability of procuring the money necessary to create the ditches with which to distribute the water. British America bounds this Territory on the north, with Nevada and Utah on the south, and the mountain regions lie west, and are the source of all the streams. The great Snake River has its source in the great plateau of the continent, by Professor Hayden said to be the first great upheaval of this continent. It is 12,113 feet above the level of the sea.

I have taken the liberty of making these few remarks and thank you for the permission.

STATEMENT OF JOSEPH C. STRAUGHAN, SURVEYOR-GENERAL OF IDAHO TERRITORY.

The CHAIRMAN. Have you made an examination and survey, so far as you are able, in regard to the irrigation of this Territory?

Mr. STRAUGHAN. No. The Governor and myself, acting in compliance with your request and that of Engineer Hinton, have gotten reports from all over the country, from surveyors and representative citizens, on

the matters pertaining to irrigation. I have had those reports compiled in my office, so as to present the statistics, with a map of each county, very fully, and also prepared in connection with it a general report.

The CHAIRMAN. Have you the general report in your hand?

Mr. STRAUGHAN. Yes.

The CHAIRMAN. Perhaps it would be well to read that, and then if there be questions the committee would like to ask they can be propounded. That general report will give us an idea of the situation in a more condensed form.

Mr. STRAUGHAN. I think so. I present, before reading the report, copy of letter sent from my office, at the suggestion of Engineer Hinton, with the committee and by the wish of its chairman.

DEPARTMENT OF THE INTERIOR, UNITED STATES,
SURVEYOR-GENERAL'S OFFICE, DISTRICT OF IDAHO,
Boisé City, June 15, 1889.

To ———

DEAR SIR: The sundry civil bill enacted by Congress at its last session, approved March 2, 1889, included an item of \$250,000 "for the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation and the segregation of irrigable lands in such arid region, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and for ascertaining the cost thereof."

By request of its chairman, Hon. William M. Stewart, of Nevada, I am preparing for the United States Senate Committee on Irrigation certain statistics on that subject. Will you please aid me in this by an early reply to the following:

First. On what streams in your county has irrigation been effected, and to what extent?

Second. On what streams is irrigation practicable, and to what extent?

Third. For what length of time, per yearly average, does each stream furnish sufficient water to irrigate its irrigable lands? And—where the water in streams is insufficient—are there sites for reservoirs wherein large bodies of water may be impounded at a moderate cost?

It will be sufficient to give the distance irrigated and irrigable in miles along the several streams, and for width an average according to your judgment and recollection or as you may find by inquiry from others.

I send you, per this mail, a map of Idaho. Where it notes the names of streams please give said names in your report. Where names of streams are not shown on the map please state the local designation thereof and properly describe its location, that I may enter it upon my office map.

All facts are desired which you may be able to gather and formulate relating to the storage, sources, and distribution of water, and all precipitation for use in agricultural and pastoral operations.

The number of ditches, their length, area surveyed, duty of water, value of crops, sources of water, irrigable areas, etc., will be of great service.

The views of all practical and competent observers on the problems involved will also be of importance.

I herewith inclose a circular letter of this date, from his excellency, Governor Shoup, bearing upon this subject, and which is self-explanatory. Careful perusal thereof is earnestly requested.

This matter of irrigation is of vital importance to Idaho, and I can not urge upon you too strongly the need of gathering all obtainable information and data for the purpose stated.

Please give the matter immediate and careful attention, if possible, and transmit your report to this office, together with the map, in time for receipt here not later than July 15 next, as the Senate committee will be at Boisé City early in August.

In the inclosed letter of Governor Shoup you will find the name of a representative gentleman in your community who will doubtless assist you.

Hoping and anticipating your active co-operation for and on behalf of irrigation of Idaho, I am,

Very respectfully, yours,

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

The report itself is as follows :

GENERAL IRRIGATION REPORT OF JOSEPH C. STRAUGHAN, UNITED STATES SURVEYOR-GENERAL FOR IDAHO.

OFFICE OF UNITED STATES SURVEYOR-GENERAL,
Boisé City, Idaho, August 17, 1889.

GENTLEMEN: In the subjoined report upon the arid region of Idaho I do not include the counties of Idaho, Latah, Nez Percé, Shoshone, and Kootenai, which are not arid and do not require artificial irrigation except to the extent stated by Messrs. C. P. Coburn, W. P. Bell, G. A. Manning, and William Ashley, copies of whose reports are herewith submitted.

The remainder of Idaho Territory occupies an approximate area of 50,286 square miles (or 224 miles square), four-fifths of which is high mountain table-lands, which accumulate during the winter a depth of from 4 to 8 feet of "packed" snow. On the Sawtooth Range twice this depth is reported. Of the remaining one-fifth about 1,091 square miles are now irrigated or in process, whilst the rest, being 10,904 square miles, or 7,002,000 acres, remains unreclaimed desert land of superior quality when irrigated.

Looking out over this 6,500,000 of acres we have an abundant water supply on the mountains, at sufficient elevation and convenient distance, leaving only the one problem for our solution of how best to bring this water upon these lands.

In the prosecution of so great a work it is usual and generally expected that some great obstacle may intervene, some questionable means be resorted to, or some costly structures be required; but in this case there is nothing of the kind. Our task is only to choose between the use of storage or not to use it in the several localities.

On this subject the reports from the several counties furnished my office by the surveyors and representative citizens of each present a bird's-eye view of the whole, by which it is seen that there are four or five main districts, each having its own distinctive features.

The Sawtooth Mountains and their extension, the Bitter Root Range, appear to form a climatic division. On the east it is arid and on the west humid; hence the county of Lemhi needs irrigation for half a million of acres, whilst the counties west, as above stated, require no irrigation.

Coming to the great valley of Snake River, with its vast volume of water, one's first thought would embrace the whole by a duplex canal, which should skirt the foot hills on either side, requiring only to be long enough to reach the lower end at the Weiser and Owyhee Rivers, and large enough to carry all the water needed.

With artificial storage at its head near the National Park, enforced by reservoirs along its route, this plan may prove the cheaper, if we assume that all the good arable lands shall be reached and supplied with water; but if we adopt for storage any of these sites that we find so feasible and inviting along the foot-hills on both sides, there are high table-land districts that would thus be sufficiently supplied without a main canal from the Upper Snake River.

The topography of all this valley, from the mouth of the Weiser up to the confluence of the Teton, some 500 miles, presents three great planes of inclination. The upper one, from Teton to the American Falls, descends at an average rate of about 6 feet per mile; from the American

Falls to Glenn's Ferry, an average of 14 feet, and from Glenn's Ferry to Weiser an average of 4 feet per mile.

Across the whole valley, from foot-hill to foot-hill, at the American Falls, there is a dike of very hard volcanic rock, over which the river has cut for itself a weir and at once descends about 50 feet; again, at the Twin Falls, 90 feet; and at the Great Shoshone Falls, 3 miles below the Twin Falls, it leaps off in a cascade of 310 feet.

It is the river and not the surface of the valley that shows this "break of grade" at those points. Above the American Falls the valley lands are not much higher than the river; below the American Falls the river is continuously in a cañon of variable depth, but always too deep to be tapped for irrigating the high plains of Cassia, Owyhee, Elmore, and Logan Counties.

Thus it is seen why the northern part of Bingham County has so great an amount of irrigation; this, too, through their unaided effort, by what they call "home companies." The north part of Bingham County reports 245,500 acres now irrigated and in process, to cost when completed \$435,000. As this portion of the county reports about 2,250,000 acres more of irrigable lands, it is very doubtful whether Snake River can furnish any excess over and above what will here be needed, unless largely aided by storage at Eagle Rock. The river was gauged by Mr. A. D. Foote, of the U. S. Geological Survey, in July last, and found to discharge only 4,450 cubic feet per second; but the river contains only about one-half as much water as ever before known at its lowest stage.

The region above the dike at American Falls has features peculiar to itself; it is where the people are cheerfully helping themselves to water. The region or district next below has only the supply from lateral streams coming from the mountains in Utah. This supply comes earlier than they need it, and fails a month sooner than does Snake River, which comes from the very high mountains in the vicinity of the National Park.

In Owyhee, Cassia, and Logan Counties, the people have under cultivation all the lands their unaided streams can supply, and the light snows of the past two winters caused such a deficiency of water as to discourage all their settlers, driving many away.

Irrigation in the counties of Cassia, Owyhee, Logan, and Elmore has reached its limit. The lateral streams are now fully utilized in so far as their normal flow will permit. A supply must come from upper Snake River, or from reservoirs yet to be constructed. They contain 2,384,000 acres of good arable land belonging to the Government, which is offered gratuitously to homesteaders who shall settle upon and reclaim it by bringing water thereon. It is irony to offer an actual settler a section of land if he will go up into the mountains and build a \$10,000 reservoir. Let this offer be made to the State of Idaho for all the lands; and, orphan as she is, she will cheerfully accept it. The sale of the lands will amply refund the outlays, and leave the water a source of revenue abundant for all State purposes forever.

Localities for reservoirs are found more numerous, larger, and less expensive than I could have anticipated. The construction of any one of them would be as remunerative as stock in any well conducted business or enterprise, and with almost no danger of loss in the investment.

A perusal of the several reports from these counties, detailing the localities and imparting much information respecting storage in general, will convince any one that the whole ground for the water supply, both by storage and the normal flow of all the streams, must receive an intelligent and faithful survey before any safe decision can be reached.

Just such a survey is now being made, and the object of this report to the honorable gentlemen of this committee is, not to advocate any theory or plan by which to get enough of our mountain snow upon our parched lands, but to furnish you with the facts and conditions really existing, by means of which you may convince your brother Senators how it is that we are practically at a stand-still now, and what a trifle it is for which we ask, that would at once populate our millions of acres of sage brush arid area.

Coming to the lower plains of Snake River Valley, as before described, we find the Boise and Payette Rivers capable, by the aid of reservoirs, of accommodating all the arable lands within their reach, except perhaps a few high plateaus of small extent.

That the Boise will soon be largely diverted through the "New York canal," belonging to the "Idaho Mining and Irrigation Company," is highly probable. Besides the 350,000 acres of arable land within hearing of the church bells of this city, there is a body of 20 or 30 sections of placer lands, needing only the water with its pressure exerted through modern appliances for mining, to wash out millions of dollars in gold.

The Payette, plus reservoirs, is also ample for its own territory. The people there can co-operate and build all needed canals and ditches. They have done so to the extent of low-water capacity of the rivers; but they can not also construct the reservoirs. The north fork of this river contains the so-called "Long Valley," 60 miles in length and 9 miles wide, with water enough for all the land without storage. Its settlement commenced only five years ago and now the population is nine hundred, while reports indicate all their land irrigated or in process by means of "home companies," every land owner being a part ditch owner. They ask no aid in any way and look with suspicion upon the outside interference as encroaching on their acquired privileges, if not upon their rights.

Washington County has also improved to the extent of the low-water capacity and beyond it; consequently her people are now in great need of storage reservoirs which they are not able to construct, nor will they become able if such dry winters continue much longer as were the last two.

Lemhi County is also a district of irrigation by itself, the only one whose drainage is in the Salmon River that needs irrigation, because it lies east of the Sawtooth Mountains, the atmospheric dividing line before mentioned. Its total area is 4,300 square miles, of which 18 per cent., or one-half million acres, is arable.

This percentage is very large, considering its close proximity to the very crest of the Rocky Mountains on the one hand, and the equally high Sawtooth Range on the other.

The valleys of the Lemhi and the Salmon Rivers contain all or nearly all the arable land in this district. Near to these rivers are narrow strips or fringes of low bottom land easily irrigated, and now containing the only settlements of farmers. The bench or second bottom lands occupy a plane 50 to 100 feet higher, onto which the river water might and must be brought; but the expense has been too great for the present settlers.

Along the many creeks intersecting these table lands irrigation on a small scale is practiced to the extent of their low-water capacity, which may be largely increased by storage on each. For such purposes the sites in most instances are good.

At the head of the Lemhi is a good location for a large reservoir. It is about 2,000 feet above Salmon City, 49 miles distant, on an average

of 40 feet per mile. The fall in Salmon River in this county averages about 15 feet per mile.

It is reported that no natural obstacle would prevent the supply for the Lemhi Valley coming from a storage basin on the summit by means of a canal on each side. To these canals might be added as many lateral reservoirs as shall be found necessary and when found necessary. In either case the irrigation of the Lemhi Valley will cost less, computing by ratio per acre on the land reclaimed, than any valley of equal extent in Idaho.

Along the Salmon River Valley explorations, with the view of large canals, have not been made; but as the fall is so great and the quantity of water very abundant, it is a foregone conclusion that this valley is among the most favorably located for purposes of irrigation.

In order that the information on the subject of irrigation and the topography of Idaho thus obtained by this office may be briefly shown, I have caused all the regular reports from the surveyors and prominent citizens in the several counties, to be engrossed on type-written copies, for convenient reference when desired.

From these reports, and from all available sources, I have compiled condensed statistics and salient facts as to the respective counties separately. Each county report is accompanied by a map to illustrate the statements of the report, all arranged in portfolio form.

The matter is thus presented as fully as possible, under the circumstances, all of which is respectfully submitted.

Very respectfully, your obedient servant,

JOSEPH C. STRAUGHAN,

United States Surveyor-General for Idaho.

THE UNITED STATES SENATE COMMITTEE ON IRRIGATION.

ADA COUNTY.

REPORT BY L. F. CARTEE.

BOISÉ CITY, IDAHO, July 12, 1889.

SIR: Your letter of the 8th ultimo, with inclosures, came duly to hand; the map of Idaho was also received, and is herewith returned to your office.

The subject-matter of your letter, the irrigation and reclamation of arid lands in the southern portion of Idaho, is of vital interest not only to the Territory of Idaho but to the General Government.

I deeply regret that circumstances beyond my control have prevented me from devoting any time to the subject other than making the estimates and embodying them in this communication, in answer to the following questions submitted in your letter:

First. On what streams in your county has irrigation been effected, and to what extent?

Second. On what streams is irrigation practicable, and to what extent?

Third. For what length of time, per yearly average, does each stream furnish sufficient water to irrigate its irrigable lands? And where the water in streams is sufficient are there sites for reservoirs wherein large bodies of water may be impounded at a moderate cost?

In answer to the first question, I will say there is not a stream in the county, and scarcely a spring or rivulet that has not been utilized for irrigating purposes; and outside of the Boisé and Payette Rivers there are over 100 miles of small ditches, and where the supply in its natural flow is not sufficient to irrigate the lands now in cultivation; but were the waters impounded, there would be sufficient for many thousand acres now entirely worthless.

Our two large streams before named, Boisé and Payette, furnish the main supply of water for irrigating and manufacturing, and the volume is ample for all time, without a question to the contrary.

There are some locations in the county where it will be impracticable, without very large expense, to irrigate the land and the time has not come that will warrant the outlay.

On the Boisé River there are about thirty-six ditches aggregating 308 miles, with a carrying capacity of over 300,000 cubic inches, sufficient for 400,000 acres of land, if used with care and the irrigation be done on correct principles.

There are on the Payette twenty-three ditches aggregating something over 180 miles, with a carrying capacity of 56,000 cubic inches, but the stream has volume enough to irrigate all the lands adjacent to its banks, and the table lands adjoining.

There are only a few locations in the county where water can be impounded with practical results. The Willow Creeks, Five, Ten, and Fifteen Mile Creeks, Dry Creek and one or two of its branches.

Respectfully, your obedient servant,

L. F. CARTER,

United States Deputy Mineral Surveyor.

JOSEPH C. STRAUGHAN, Esq.,

United States Surveyor-General for Idaho.

REPORT BY E. A. STEVENSON.

BOISÉ CITY, July 16, 1889.

SIR: By request of Hon. George L. Shoup, governor of Idaho, I have the honor to furnish your department a brief statement of the present and proposed system of irrigation in the county of Ada.

I also annex hereto much valuable information furnished me by E. H. Hesse, esq., county surveyor of this county, in which is detailed "water supply, canals in operation, their length, name, capacity," and other valuable statistics.

Boisé River rises in the high mountains of Boisé County, and runs almost directly west through the entire length of Ada County, and is the main water supply for the southern portion thereof. Out of this beautiful, never-failing mountain stream the water has been taken to reclaim all the lands known as Boisé Valley, including this city, which was, before reclamation, one of the most desolate, arid, and worthless portions of our desert lands; and yet the water supply of the river, if properly utilized, is ample to irrigate 150,000 acres of table-land, lying on the south side of the river and covered by the proposed New York canal. This vast tract of most excellent agricultural land is most admirably adapted to fruit raising and farming, and, if properly cultivated, will produce from 30 to 40 bushels of wheat and from 5 to 7 tons of hay per acre. Apples, pears, plums, peaches, grapes, and berries will grow in abundance, but all must depend on the water for irrigation.

Probably no other section offers better facilities and inducements for the development of a practical system of irrigation than does this.

The only other river of importance in this county is the Payette, situated in the northwestern portion. It has almost an unlimited amount of water at all times, more than ample to irrigate all the lands within its reach.

If two large canals were taken out of this river, about 6 miles above Emmettville, one on each side of the river, it would reclaim more than 200,000 acres of most excellent agricultural land and furnish homes for thousands of actual settlers, who would soon surround themselves with all the comforts of civilization, so easily obtained in the mild and uniform climate of Idaho.

Again, this river runs for more than 150 miles through an almost inexhaustible forest of the finest pine, fir, and spruce timber in the Territory; hence the great water-power of this magnificent river must, at no distant day, be utilized, not only for irrigation but manufacturing purposes as well.

The only streams in this county where the water could be impounded by dams and reservoirs to any great advantage are Dry Creek, which enters into Boisé River about 10 miles below this city, Willow Creek, which also empties into Boisé River about 25 miles below here, and the Big and Little Willow Creeks, which empty into the Payette River about 6 miles above its mouth.

In each of these streams is a large volume of water in the winter and spring months which, if properly impounded and saved, would be ample to reclaim many thousand acres of most excellent land in the valleys of each of these streams.

Two or three substantial dams and reservoirs on each of these creeks could be constructed at small cost to the Government, which would reclaim some of the very best land in Idaho.

In order that people may fully realize what virtue there is in water on these arid lands, which are worthless until reclaimed, I would here state that since my residence in Idaho, Boisé City and the beautiful farms above and below the city have

been changed from the very poorest portions of our desert lands to fine residences, embowered in trees and vines, and surrounded with grass, flowers, and orchards bending with their loads of apples, pears, peaches, plums, and prunes, of almost every variety, in abundance.

In addition to the names and number of ditches mentioned in the able report of Surveyor Hesse, I would state that almost every farmer, where the water was easily taken from the rivers, has constructed private ditches for his own use, which are omitted in Mr. Hesse's report.

All the locations where water could be taken from the rivers by canals at small expense, have long since been appropriated by the early settlers.

The three large canals before referred to, viz, one canal from Boise River about 12 miles above this city, and one on each side of the Payette River 6 miles above Emmett, will reclaim at least 350,000 acres of good agricultural land, but the construction of these canals will be expensive and beyond the reach of our home capital. It is therefore to be hoped that the United States Government, out of her great wealth, will appropriate sufficient money to make these vast tracts—of now worthless lands—productive and valuable.

I am confident, if the proper showing is made to the very able committee of the United States Senate who have in charge this great subject of irrigation, Idaho will be treated honestly and fairly.

Respectfully, yours,

JOSEPH C. STRAUGHAN,
United States Surveyor-General.

E. A. STEVENSON.

REPORT BY E. H. HESSE, COUNTY SURVEYOR.

COUNTY SURVEYOR'S OFFICE,
Boisé City, Idaho, June 14, 1890.

SIR: In compliance with your request, to gather and prepare statistics referring to the present and prospective system of irrigation in this county, the extent of the canals now in operation, and other points in this connection, I beg leave to submit to you the following items:

GENERAL FEATURES.

I will give a few outlines of the frame-work of this county to qualify the descriptions following on the subsequent pages:

Ada County is chiefly an agricultural county, embracing the spacious valleys of Snake, Boise, and Payette Rivers. The northeastern corner is mountainous, interspersed with beautiful smaller valleys, such as Dry Creek, Willow Creek, etc. In the northwestern portion the extensive plateau of rich and fertile soil has not yet been touched by the plow. The western portion, between Boise and Snake Rivers, embraces the Deer Flat country, which is as good in quality as it is vast in extent. Considerable energy is now displayed in bringing this section under water and plow. The southeastern portion is similar in character of soil, but the elevation of this plateau will not permit any water to be brought upon it, excepting from canals, heading at Snake River in the vicinity of the falls. All the above-mentioned high plateaus and hills afford good grazing.

IRRIGATION SYSTEM—WATER SUPPLY.

Boisé and Payette Rivers are the only streams that will supply the necessary amount of water for the available lands in this county. Owing to the fact that they reach our boundary from high mountains the water diverted may be successfully conducted to the high plateaus.

Snake River runs along this county in a deep gorge with hardly any more fall than the general contour of the country.

The former two rivers are—and will be with an increased demand—sufficient in volume for this supply, leaving out only the mountainous portion and the southeast flat, which latter is entirely dependent on Snake River as before stated.

CANALS IN OPERATION—BOISÉ RIVER.

South side.—The first canal emanating from Boise River, nearest the eastern boundary of the county, is the Costin canal, heading at the mouth of the cañon about 8 miles above Boise City. The water right which attaches to it warrants a stream 12 feet wide at the bottom. It now extends but a few miles in length as far as its capacity will permit.

The next, following down the river, is the Bois  and Nampa canal, better known as "Ridenbaugh ditch," heading about 3 miles below the former. It gradually ascends the benches and appears opposite Bois  City about 70 feet above the level of the river. The general course is westerly, and for the first 7 miles the bottom measures 20 feet in width. This is the terminus of the enlargement recently completed, and from this point it feeds a number of natural drains, from which the scattering ranches take water. The supply thence is lost by "seepage," by evaporation, and returns to the Bois  River.

The extension of this canal is under survey at present. The proposed line will cross the Oregon Short Line Railway between Kuna and Nampa, and reach Deer Flat at a very high point.

A small canal built by M. E. Payne and others comes next. It answers the purpose for which it was constructed, irrigating about six ranches.

The Settlers ditch, although not in operation yet but fast approaching completion, is next in rotation. It will cover a beautiful scope of agricultural country. Leaving the river about 4 miles below Bois  City, it reaches the top of the bench about 4 miles farther, passing through a cut 25 feet deep, thence it takes a southwesterly direction following the contour of the country, and below the proposed extension of the Ridenbaugh ditch, to Deer Flat. It is provided with head-gates for 20,000 miner's inches of water, but will in the beginning have a capacity of only 9,000 inches. The total length will be, like that of Ridenbaugh canal, between 30 and 40 miles.

The Caldwell canal heads about 18 miles below Bois  City, runs westerly some 15 miles, and covers the lower bench lands. It measures about 6 feet in the bottom and returns the surplus water into Bois  River.

Below Caldwell some minor attempts have been made, conveying the water only into natural drains, in which it runs to points where it is needed and taken out. The "Methodist ditch" was constructed but is not in operation.

North side.—The oldest canal, known as the "Walling ditch," takes its water about 4 miles above Bois  City. Two miles from the head it operates a saw-mill, from which a stream in a 10-foot channel is conveyed over the higher lands around Bois  City, which derives almost exclusively her water supply from this source; and a great deal of the verdant beauty of our town is owing to this ditch. Beyond the city it is used until the supply is absorbed. It is calculated to extend this canal to the Dry Creek Valley, and eventually to Willow Creek, a total length of about 30 or 40 miles.

Several miles below start the "Ellis and Jacobs" ditches, which flow through the lower streets of Bois  City, and one covers several hundred acres beyond, while the other runs a flouring-mill.

Dry Creek canal is taken from the river 5 miles above the mouth of Dry Creek. It recedes from the river until reaching the foot-hills, which it follows until attaining a total length of about 20 miles. The "Moore and Stephenson ditch" is taken out of this, which covers several hundred acres of land above the main canal.

Foote's Mill ditch, still below, has only a limited scope of country, besides running his flouring-mill at Middleton.

Opposite Caldwell emanates the "Seabee canal," which, if I am not mistaken, is 14 feet wide at the bottom, and is destined to cover all the lower lands as far as Snake River.

PAYETTE RIVER.

South side.—Only a small ditch has been taken out at a point called Black Ca on, about 5 miles up from the town of Emmett. This, however, can not do very great service, because of not reaching high enough.

The "Kelly and Bush canal" leaves the river 4 miles below Emmett, and continues in a northwesterly direction about parallel to the river towards Snake River, where it will terminate when finished. The land under it is of excellent quality, but only scattered portions are under cultivation. The main part of the ditch is 6 feet wide at the bottom for a distance of 10 miles, balance 3½ feet, and the total length about 30 miles. A reservoir is built at McFarland gulch, which will overflow 160 acres from 5 to 8 feet deep.

The Stevenson and Noble canal is taken out of the river about 6 miles below Emmett. It is 8 feet wide on the bottom, carries 5,000 inches of water, and extends in a westerly direction about 20 miles. Cost of construction \$20,000. The canal is an entirely private enterprise, and is owned by E. A. Stevenson and William B. Noble. It covers about 8,000 acres, of which 2,200 acres belong to owners of the canal. Only surplus water is furnished to outside parties.

North side.—On the north side of the river only one canal can be mentioned—that of the Payette Company, heading about 8 miles above the town of Payette, and covering the settlements along this valley to the northern county boundary. Its dimensions are not over 6 feet at the bottom, and the length to the county line about 12 miles.

PROSPECTIVE CANALS.

All our great hopes of populating the larger portions of the desert land with bona fide settlers have been attaching to the early completion of two large canal systems, one from the Boise River—the Idaho Mining and Irrigation Company; the other from the Payette River—the Payette Irrigation Company; the latter with two main canals, one on each side of the river. Both schemes are beyond capital, which fact makes their construction a mere possibility unless the Government assists.

The plans of the first-mentioned enterprise show a system of main and lateral canals of about 130 miles, with a tributary area of agricultural and mineral land of nearly 300,000 acres.

The plans of the second enterprise have not yet assumed any definite shape, but the estimated quantity of land to irrigation and reclamation would exceed 255,000 acres.

The projected Phyllis canal has had some work done. Starting on the south side of Boise River about 10 miles below Boise City, it has for its objective point the Deer Flat country. It is intended to cover the lower lands, which would be too remote for the Settlers and Ridenbaugh ditches.

Besides the unparalleled advantage of water-power for manufacturing purposes, the log-floating traffic, on the larger canals, would be no unimportant affair. Both rivers head in almost inexhaustible timber regions, and the cheap transportation of logs to the carriage of the saw-mill would encourage this industry greatly.

PLACER MINING.

The placer interest connected with the construction of canals is but little inferior to the agricultural. All of the three rivers have placer ground, but especially Snake River; and since its waters are not available and other resources are at best problematical, the placer field lay an idle waste of dormant wealth. In this county several hundred square miles of placer ground may be estimated.

NOTES.

The canals in operation and those under contemplation in this county are inadequate to the service, while the water is permitted to flow unused through this great drainage channel, Snake River.

Allowing the duty of water to be double that contemplated by the desert act, to wit, one miner's inch for 2 acres, or 1 cubic foot per second for nearly 100 acres, it has been demonstrated in this county that, when continuous stretches are irrigated, heavy crops have been raised and the duty of water becomes much larger. The underlying clay accounts for this.

CROPS AND CLIMATE.

Since the soil in this county is equally as rich as that of other surrounding counties, I refer this point of productiveness and crops to abler and more experienced pens, while the climate is much more effectually enjoyed personally than by the proxy of written reports.

In submitting these lines I would apologize for all defects, inasmuch as I was unable to secure all the information desired in the time allotted.

Very respectfully, your most obedient servant,

E. H. HESSE,

County Surveyor, Ada County, Idaho.

Hon. E. A. STEVENSON,
Boise City, Idaho.

REPORT BY C. H. TOMPKINS, JR.

BOISE CITY, August 15, 1899.

SIR: In accordance with your request the following statement of the works and plans of the Idaho Mining and Irrigation Company is respectfully submitted:

The point of diversion of the main line of the Idaho Mining and Irrigation Company's system (often referred to as the "New York Canal") is on the left bank of the Boise River, about ten miles above Boise City. There exists at this point an excellent location for dam, waste-weir, and head-gates, all of which can be founded on solid rock.

The lands to be covered lie in Ada County, between the Boise and Snake Rivers. They are of the first quality and have an area of about 350,000 acres.

There is also, under the line of canal, a large body of place lands, extending for many miles along the Snake River, above the mouth of the Boise. The length of canal, from head to mouth of Boise River, will be about 70 miles. Dimensions at head: 65 feet wide at surface of water and 10 feet deep; grade, 2 feet per mile. Estimated capacity, 2,915 cubic feet per second, or about 140,000 miner's inches. For the supply of the lower portions of the tract, and for a quick line to the placers, is being constructed the Phyllis Canal or "lower line" of the company's system.

This will take water from the Boise River at the lower end of Eagle Island, about 14 miles below Boise City.

The length of the Phyllis line is about 50 miles. Dimensions at head, 22 feet wide at water surface and 5 feet deep. Capacity, 175 cubic feet per second, or about 8,500 miner's inches under a four-inch pressure.

The company has been very thorough in its preliminary work, including careful and detailed surveys. There have also been selected, in a trip made for that purpose, reservoir sites on Smith, Blind, and Fall Creeks, for husbanding the spring supply of the river if it should prove necessary to do so. These sites are unusually favorable, and reservoirs of large capacity can there be cheaply constructed.

Of the Phyllis or "lower line" about 2 miles have been completed. Work on the main line has thus far been confined to the upper 2 miles, which is in cañon, with much work in loose rock and large boulders, but no solid rock cutting. The work has been, until recently, in charge of Mr. A. D. Foote, now irrigation engineer for the Snake River division of the U. S. Geological Survey.

Over the whole of the proposed system, the surveys show no difficulties of magnitude, and the lands can be covered at very moderate cost.

Respectfully submitted.

C. H. TOMPKINS, JR.,
Engineer and Manager.

J. C. STRAUGHAN,
Surveyor-General, Territory of Idaho.

Summary of Ada County works.

Canals and ditches completed.	Length.	Size on bottom.	Location of head and remarks.
<i>Boise River.</i>	<i>Miles.</i>	<i>Feet.</i>	
Coston	6	12	8 miles above Boise City, south side; is to be extended.
Ridenbaugh	7	20	5 miles above Boise City, south side; is to be extended to Deer Flat; in all, 35 miles.
Payne's	4	5	Above Boise City, south side; accommodates five or six ranches.
Settlers (in progress)	35	18	4 miles below Boise City, south side; is half built.
Phyllis (in progress)	38	14	Heads at Eagle Island, south side; is half built.
Caldwell	15	6	18 miles below Boise City, south side.
Walling	12	10	4 miles above Boise City, north side; runs through Boise City; is to be extended.
Jacobs & Co	4	5	Runs through Boise City; serves 600 acres land and a grist mill.
Dry Creek	20	6	5 miles above Dry Creek.
<i>Payette River.</i>			
A small ditch	4	4	5 miles above Emmett at the Black Cañon.
Kelly & Bush	30	6	4 miles below Emmett; has a reservoir 160 acres.
Stevenson & Noble	20	8	6 miles below Emmett; has capacity for 5,000 inches—private property.
Payette Company	12	6	8 miles above Payette.
CANALS PROPOSED.	207		
Idaho Mining and Irrigation Company:			
Main canal	76	24-14	Starts out from Boise River 12 miles above city, south side; elaborate surveys and estimates made and the work progressing slowly; 300,000 acres will be covered and a great placer-mining district near the mouth of Boise River.
Laterals	55	6-10	
Payette Irrigating Company:			
Two main canals	75	20-14	Starts at the Black Cañon on the Payette; surveys incomplete; will cover 255,000 acres.
Laterals	45	5-8	

Acres irrigated: 60,000; irrigable: 900,000.

ALTURAS COUNTY.

REPORT BY JOHN B. HASTINGS, UNITED STATES DEPUTY MINERAL SURVEYOR.

KETCHUM, IDAHO, August 9, 1889.

SIR: Regarding irrigable areas and ditches in this county, there are between Sawtooth and East Fork of Wood River practically no areas under cultivation. Other portions of the county Messrs. Mandell and Burkhardt say they will report upon.

Ditches in this part of the county.

Locality.	Length.	Acres cultivated.	Capacity.
	<i>Miles.</i>		<i>Inches.</i>
From Trail Creek	3½	200	1, 700
Do	2	100	1, 700
Do	1	20	200
From Wood River	1½	200	1, 000
Do	1½	50	1, 000
Do	3½	50	1, 000
Do	1	20	500

Total crop value of all these areas, \$10,000. Trail Creek and Wood River carry sufficient water all the year for above ditches.

Ten miles above Ketchum, on Wood River, there is a quite recent lake bed; a dam 400 feet long, 100 feet high would convert it into a reservoir 2 miles long, half a mile wide. Such dam would cost \$150,000 or less. These measurements do not pretend to accuracy. There are no other suitable sites for cheap reservoirs, to my knowledge, except such as will be reported by Messrs. Burkhardt and Mandell.

Very respectfully, yours,

JOHN B. HASTINGS.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

REPORT BY H. Z. BURKHART AND FRANK C. MANDELL.

HAILEY, IDAHO, August 10, 1889.

SIR: In compliance with your request of June 8, asking for information respecting the supply of water for irrigation, etc., we have the honor to report that Wood River furnishes ample water in ordinary seasons for the irrigation of all arable land traversed by it in Alturas County.

The supply of water, however, is insufficient for purposes of irrigation of land a few miles south of Hailey, in Logan County.

Eleven miles north of Ketchum there is an excellent natural site for a dam and storage reservoir, which can be constructed at comparatively small expense, and which would be amply sufficient to supply the entire arable territory tributary to Wood River.

Deer Creek, East Fork, and Trail Creek, branches of Wood River, are insufficient in dry seasons to supply the valleys through which they run.

Upon these streams there are favorable locations where dams and storage reservoirs can be built at no great expense. All of the land covered by these streams is very productive when well watered.

There is a small portion of Alturas County and a large part of Custer County lying within the valley of Big Lost River, comprising a large tract of land now wholly unproductive for want of water. We are reliably informed that the topography of the country affords sufficient natural sites for saving and utilizing the water, which otherwise runs to waste during the spring freshets.

Within the present limits of Alturas County there are no lands requiring irrigation other than those adjacent to the streams already mentioned.

All of which is respectfully submitted.

H. Z. BURKHART,
Committeeman.
FRANK C. MANDELL,
County Surveyor.

GEORGE L. SHOUP, *Governor.*

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REPORTS FROM ALTURAS AND BEAR LAKE COUNTIES. 331

SUPPLEMENTAL REPORT BY FRANK C. MANDELL, UNITED STATES DEPUTY MINERAL SURVEYOR.

HAILEY, IDAHO, August 14, 1889.

SIR: Herewith I send map showing approximate locations of dam and water storage sites upon the principal streams of Alturas County.

Upon Lost River, at the Narrows, about 11 miles above its junction with Pass Creek, and also on Pass Creek just above where it joins Lost River, are very favorable locations for dams and storage reservoirs.

In the valley of Lost River there is an area of upwards of 100,000 acres of land capable of producing fine crops with water; 5,000 acres are now tilled, and the river, in average seasons, furnishes water for about 7,000 acres more, i. e., a total capacity for about 12,000 acres.

Deer Creek has a tributary territory of 2,500 acres. It will irrigate 1,000 acres in favorable seasons, and about that amount is cultivated, if we include hay lands.

East Fork irrigates about 800 acres of the 2,000 acres in its valley capable of cultivation.

Trail Creek embraces 1,000 acres and waters about 500 acres.

Upon all these creeks good sites for storage-dams can readily be shown. The 12,000 acres of arable land within the present Alturas County, and within the valley of Wood River, can be readily watered by Wood River. About 7,000 acres are under cultivation. Wood River, however, falls short of irrigating its tributary territory within the county of Logan. At the dam location cited in report, the valley narrows to about 350 feet, and just above this place a broad extensive meadow tract affords the best facilities for an artificial lake or storage reservoir.

Very respectfully,

FRANK C. MANDELL,

United States Deputy Mineral Surveyor and County Surveyor.

JOSEPH C. STRAUGHAN,

United States Surveyor-General, Boise City, Idaho.

Summary of Alturas County report.

Localities.	Lands—		Remarks.
	Irrigated.	Irrigable.	
	<i>Acres.</i>	<i>Acres.</i>	
Lost River	3,000	100,000	Might irrigate 7,000 acres more. One very good dam-site. Good dam-site. Do. Do.
Wood River	7,000	12,000	
Trail Creek	500	1,000	
Deer Creek	1,000	2,500	
Other small streams.....	1,000	2,500	
	14,500	118,000	

Recapitulation.—Total area of county, 2,100 square miles; ordinary snow-fall, 20 feet (Sawtooth Mountains); ten ditches, 18 miles long, average capacity, 1,700 inches.

BEAR LAKE COUNTY.

REPORT BY J. C. RICH, COUNTY SURVEYOR.

Georgetown.—Four main canals; length, 16 miles; size, 6 by 2 feet; cost, \$2,500; owned in common by inhabitants; amount now irrigated, 1,200 acres; amount yet vacant for want of water, 2,000 acres; cost of reservoir (estimated), \$5,000.

Dingle.—Two main canals; length, 10 miles; average size, 12 by 2 feet; cost, \$5,000; owned in common by inhabitants; amount now irrigated, 2,000 acres; amount now vacant that could be irrigated by reservoir, 2,000 acres.

Preston.—One main canal $8\frac{1}{2}$ miles long; size, 12 by 4 feet; cost, \$10,000; owned in common by inhabitants; total amount irrigated, 1,500 acres; cost of reservoir, \$5,000 (estimated); amount of land now vacant that could be irrigated from reservoir, 3,000 acres.

Montpelier.—Five main canals; length, 10 miles; average size, 8 by 2 feet; cost, \$5,000; owned in common by inhabitants; total amount of land now irrigated, 1,000

acres; cost of reservoir (estimated), \$4,000; amount of land now vacant that could be irrigated from reservoir, 2,000 acres.

Bennington.—Two main canals, ten lateral canals; total length, 16 miles; average size, 4 by 2 feet; cost, \$1,000; owned in common by the inhabitants; amount of land now irrigated, 1,000 acres; cost of reservoir estimated at \$5,000; amount of land now vacant that could be irrigated with reservoir, 5,000 acres.

Liberty.—Four main canals; total length, 21 miles; average size, 4 by 2 feet; cost, \$6,000; owned in common by citizens; amount of land now irrigated, 2,000 acres; cost of reservoir estimated at \$10,000; amount of land now vacant that could be irrigated from reservoir, 3,000 acres.

Ovid.—One main canal; length, 10 miles; average size, 6 by 2 feet; cost, \$4,000; owned in common by the inhabitants; total amount of land now irrigated, 800 acres; amount of land now vacant that could be irrigated from Liberty Reservoir, 1,000 acres.

Nonnan.—Five main canals; total length, 10 miles; average size, 4 by 2 feet; cost, \$1,000; owned in common by inhabitants; total amount of land now irrigated, 1,000 acres; cost of reservoirs (estimated), \$5,000; amount of land yet vacant that can be irrigated from reservoirs, 1,000 acres.

Thomas's Fork.—Four main canals; total length, 14 miles; average size, 10 by 2 feet; cost, \$5,000; owned in common by inhabitants; total amount of land now irrigated, 1,500 acres; cost of reservoirs estimated at \$5,000; amount of land yet vacant that could be irrigated from reservoir, 10,000 acres.

St. Charles.—Eight main canals; total length, 20 miles; average size, 6 by 2 feet; cost, \$10,000; owned in common by the inhabitants; amount of land now irrigated, 3,500 acres; cost of reservoir estimated at \$1,000; amount of land yet vacant that might be irrigated from reservoir, 1,500 acres.

Paris.—Four main canals; total length, 12½ miles; average size, 6 by 12 feet; cost \$10,000; owned in common by the inhabitants; amount of land now irrigated, 2,000 acres; cost of reservoir estimated at \$5,000; amount of land yet vacant that could be irrigated from reservoir, 5,000 acres.

Fish Haven.—Five main canals; total length, 13 miles; average size, 4 by 2 feet; cost, \$4,000; owned in common by the inhabitants; amount of land now irrigated, 1,000 acres; cost of reservoir estimated at \$5,000; amount of land yet vacant that could be irrigated from reservoir, 1,000 acres.

Bloomington.—Four main canals; total length, 15 miles; average size, 6 by 2 feet; cost, \$8,000; owned in common by the inhabitants; amount of land now irrigated, 2,000 acres; cost of reservoir estimated at \$2,500; amount of land yet vacant that could be irrigated from reservoir, 2,500 acres.

Individuals.—About ten isolated canals owned by individuals. Total length, 30 miles; average size, 4 by 2 feet; cost, \$2,000; amount of land irrigated, about 1,000 acres.

RECAPITULATION.

Districts.	No.	Miles.	Size.	Cost.	Irrigated.	Irrigable.	Cost of reservoirs.
			<i>Feet.</i>		<i>Acres.</i>	<i>Acres.</i>	
Georgetown.....	4	16.0	6 x 2	\$2,500	1,200	2,000	\$5,000
Dingle.....	2	10.0	12 x 2	5,000	2,000	2,000	5,000
Preston.....	1	8.5	12 x 4	10,000	1,000	3,000	4,000
Montpelier.....	5	10.0	8 x 2	5,000	1,000	2,000	5,000
Bennington.....	2	16.0	4 x 2	1,000	1,000	5,000	5,000
Lateral.....	10						
Liberty.....	4	21.0	4 x 2	6,000	2,000	3,000	10,000
Ovid.....	1	10.0	6 x 2	4,000	800	1,000	
Nonnan.....	5	10.0	4 x 2	1,000	1,000	1,000	5,000
Thomas's Fork.....	4	14.0	10 x 2	5,000	1,500	10,000	5,000
St. Charles.....	8	20.0	6 x 2	10,000	3,500	1,500	1,000
Paris.....	4	12.5	6 x 2	10,000	2,000	5,000	5,000
Fish Haven.....	5	13.0	4 x 2	4,000	1,000	1,000	5,000
Bloomington.....	4	15.0	6 x 2	8,000	2,000	2,500	2,500
Individual.....	10	30.0	6 x 2	2,000	1,000		
	69	206.0		73,500	21,500	39,000	52,500

Crops.	Yield per acre.
Wheat.....	Bushels.. 30
Oats.....	do..... 45
Barley.....	do..... 40
Rye.....	do..... 25
Alfalfa, timothy, red-top.....	Tons..... 2

All kinds of hardy vegetables and small fruits a good yield.

Exports: Cattle, horses, sheep, lumber and all kinds of farm products.

Timber on the mountain abundant, convenient. Range for stock good. Irrigation season May, June, July, and August.

Snow-fall, average 6 to 8 feet on mountains. Water supply, great deficiency in 1888 and 1889.

Elevation, average, 5,800 feet above sea level.

BINGHAM COUNTY.

GENERAL DESCRIPTION.

Bear River.—Bear River runs for 14 miles through a narrow cañon, commencing below mouth of Cottonwood Creek, and does not offer many good locations for canals south of said cañon.

Port Neuf River.—As Port Neuf runs for nearly 30 miles through a narrow cañon, and as the lands along its lower course from Pocatello to Snake River will be more practicably irrigated by Snake River water, a canal should be constructed to run south along the foot-hills of Port Neuf Range to irrigate T. 9, 10, 11, and 12, S. of R. 37 E., and, if possible, Round Valley, in T. 13 S. of R. 38 and 39 E.

Blackfoot River.—The amount of water sufficient for its irrigable lands can only be obtained by the construction of reservoirs in the basins of John Day's Lake, in order to drain Cariboo Range, and in the narrow cañons of the spring branches emptying into Spring Forks of Big Blackfoot, in order to drain Preuss and Cariboo ranges.

Summary of Bingham County report (north part).

[Compiled from reports of Hon. W. H. B. Crow and others.]

Localities.	Lands.		Canals.	Length.	Width of bottom.	Cost.
	Irrigated.	Irrigable.				
	Acres.	Acres.		Miles.	Feet.	
From South Fork, Snake River:						
Willow Creek and its tributaries.	1,000	30,000	{ Eagle Rock and Willow Creek.	60	20 to 30	\$100,000
			{ System and laterals.	110	4 to 10	.....
South Fork Snake River, from mouth of cañon down.	1,000	10,000	{ Farmer's Friend, main.	6	20	5,000
Lyon Creek, from Hot Springs down.	400	2,000	{ Laterals	5	5	.....
Moody's Creek, from main valley up.	1,500	4,000	{ Cedar Hollow (in progress).	25	25	75,000
Teton River, from the cañon up to head.	*16,000	80,000	{ Burgess canal	15	20	8,000
			{ Rigby canal	5	18	8,000
Fall River, "Middle Fork," and tributaries, Conant & Co.	600	60,000	{ Louisville canal	8	16	10,000
			{ Market Lake County, main.	3	20	7,000
North Fork, Snake River and tributaries, up to Henry Lake.	*75,000	350,000	{ Laterals	6	6	.....
Snake River Valley, east side, from South Fork down.	*100,000	400,000	{ St. Anthony, costly.	14	30	14,000
Snake River Valley, west side, from Market Lake to American Falls.	*50,000	500,000	{ Egin, west side	10	14	8,000
			{ Rexburgh, main	7	16	17,000
			{ Laterals	12	10	.....
			{ Fall River canal	8	30	10,000
West side of Bingham County, Camas Creek, Big and Little Lost Rivers, etc.	.....	800,000	{ Lymantown canal	6	24	5,000
			{ Tanthauer canal	20	25	20,000
			{ Colorado, at Eagle Rock.	15	.....	75,000
			{ Porter County, at Eagle Rock, west side.	18	20	75,000
Total	245,500	2,236,000	.....	353	.....	435,000

*In process of construction.

Summary of Bingham County (south part).

[Compiled from Report of Oscar Sonnenkalb, United States deputy surveyor.]

Valleys.	Land irrigated.	Area.	Canals.		Land irrigable.	Acres.
		Acres.	No.	Miles.		
<i>Snake River.</i>						
Hulla, Boone, and Donaldson Creeks.	Along east bank, 17 miles, scattering.	1,500	....	17	Along east side for 35 miles.	100,000
	Along west bank, 12 miles, scattering.	1,000	5	12	Along west side for 35 miles.	20,000
	Along west bank, scattering.	3,000	3	13	Along west side	10,000
<i>Salt River tributaries.</i>						
Crow Creek; John Coy's Creek; Smoky Creek; Roney's Creek; Tin Cup Creek; Punch Bowl Creek; Grand Canon Creek; Palisade Creek.	Small ditches on small farms.	1,000	3	10	No more irrigation needed.	.....
<i>Willow Creek.</i>						
John Day's Creek and Lake.	Scattering localities.	200	3	10	Irrigation practicable for...	500
Eagle Creek						
Big Blackfoot River	Along north side 20 miles.	2,000	8	20	Main valley 20 by 60 miles; North Fork 18 by 2 miles.	10,000
South Fork	Along marsh	1,200	2	4	Further irrigation impracticable.	.....
Middle Fork		1,000	1	3	do	.....
<i>Little Blackfoot River.</i>						
North Branch	Along 3 miles.	2,000	1	6	do	.....
East Branch	Along 2 miles.	1,000	1	5	do	.....
Formation (Corral) Creek.	do	1,000	1	5	do	.....
Grave Creek	do	600	1	2	do	.....
Wolverine Creek	do	600	2	4	do	.....
Port Neuf River	Numerous small ditches.	6,000	(1)	(1)	Including table lands for 50 miles.	65,000
North and South Spring Forks.	Small tracts along each.	1,000	2	10	More irrigation impracticable.	.....
Willow Creek	do	200	1	2	do	.....
Fish Creek	do	50	1	1	do	.....
Dempsey Creek	Small tracts	2,000	2	10	A bench of land 25 miles by one-half mile.	7,000
Marsh Creek	do	100	(1)	(1)	More irrigation impracticable.	.....
Garden, Woodland, and Nine-mile Creeks.	Small tracts along each.	900	3	5	do	.....
Mink Creek	Small tracts	50	2	3	do	.....
Bannock Creek	Three large, and many small ditches.	2,000	5	20		.....
<i>Bear River.</i>						
		6,000	(1)	24	In T. 9 S., R. 39 and 40 E. and T. 10 S., R. 40 E., and Gentile Valley.	45,000
Soda Creek	Scattering tract.	300	2	8	More irrigation impracticable.	.....
Sulphur Creek	do	100	1	5	do	.....
Whiskey Creek	do	50	1	3	do	.....
King Creek	do	50	1	1	do	.....
Burton Creek	do	50	1	1	do	.....
Trout Creek	do	300	2	6	do	.....
Warm Creek	do	200	1	5	do	.....
Bridge Creek	do	300	1	5	do	.....
Cottonwood Creek	do	500	2	5	do	.....
Mink Creek	do	800	2	20	do	.....
Battle Creek	do	500	2	6	do	.....
Deep Creek	do	(1)	(1)		do	.....
Stockton Creek	do	300	1	3	do	.....
Gooseberry Creek	do	300	1	3	do	.....
Oxford Creek	do	500	1	3	do	.....
Total		39,250	68	264		267,500

RECAPITULATION (SOUTH PART).

Whole number of canals and ditches	70
Whole length of canals and ditches	364 miles.
Whole area now irrigated	39,250 acres.
Whole area capable of irrigation	267,500

BOISÉ COUNTY.

REPORT BY S. M. SISK AND BENJAMIN H. SMITH.

VAN WYCK, IDAHO, *July 5, 1889.*

DEAR SIR: I am in receipt of your circular letter of June 15 in reference to information to come before "the United States Senate Committee on Irrigation." I have waited till the last moment, expecting the map mentioned and promised in your letter, but it has not yet arrived, which I very much regret. In absence of such map I have prepared a small pen map of Long Valley, by reference to which you will be better able to understand the purport of this letter.

You are of course aware of the fact that Boise County, Idaho, is not mainly an agricultural county, but it is rather more noted for its mining interests.

(1) Garden Valley is situated partly on Middle Fork, and partly on South Fork of Payette River. The whole valley is about 8 miles in length and 1 mile in width. It has been in cultivation for several years, and where irrigation is needed it is supplied from the intersecting streams.

(2) Squaw Creek Valley is already in cultivation, and under a system of home irrigation sufficient for all purposes. It is a small valley containing about 40 homesteads.

(3) Horseshoe Bend and Squaw Creek Flat contains more than two dozen homesteads, but abundantly watered by ditches usually from the Payette River.

The main portion of Boise County that can be used for agricultural purposes, including hay and grazing, is included in Long Valley.

(4) Long Valley is about 60 miles in length and 9 or 10 miles in width, extending in a general direction from north to south, bearing a little eastward along North Payette River. From the upper lakes to the southern terminus there is an almost gradual descent, estimated at about 400 feet for the whole extent.

By reference to the map you will see the several main ditches already commenced by the enterprise of the citizens, who are forming home companies for the purpose of a general water supply, which may be needed in time of scarcity of rain-fall or of melting snow, viz:

(1) Lake Fork Ditch extends from near the source of Lake Fork Creek, about 10 miles south; and it is to be produced as far as Gold Fork. When completed it will water an area of about 10 miles long by 3 miles wide.

(2) Gold Fork Ditch commences far up Gold Fork and is to be extended southward about 10 miles, emptying into the falls of Payette River. When completed it will water an area of about 10 miles long by 3 miles wide.

(3) Big Creek Ditch is taken out of Big Creek toward the foot-hills and extends westward about 2 miles. When completed it will water an area of about 3 miles long and 1½ wide or less.

(4) Clear Creek Ditch is taken out of Clear Creek, and intended to run westward into Payette River, and when completed it will water several hundred acres of land.

(5) Tamarak Falls Ditch is to take its supply out of Payette River, at Tamarak Falls, and run southward along the western side of the valley, extending about 10 miles and emptying into Payette River. When completed it will water an area of about 10 miles long and 3 miles wide.

(6) Kimball Ditch takes its water out of Hazard Creek, and runs eastward to Payette River. It is in operation, and waters an area of about 2 miles long and 1 mile wide.

(7) There are many private ditches both in operation and in prospect, which will be completed at but little expense to individuals, and will, in most cases, water areas of from 1 to 100 acres. Under these systems the whole valley can be supplied.

As to storage supply, I would say that as the time in which irrigation can be most profitably employed is about two months, the water supply from the sources above mentioned during that period will always be abundant, or easily made sufficient when required.

I have been at some pains to consult with the citizens of Long Valley, as far as practicable, in reference to the matters elicited in your letter, and at their earnest general request, as well as accepting your timely suggestion, I would beg leave to submit the following:

(1) Long Valley began to be settled, though sparsely, as far back as five or six years ago. Several of these settlers have been improving their prospective homesteads ever since, in hope of obtaining their title in due time.

(2) The main lines for township purposes, which were surveyed several years ago, have been of great assistance ever since in helping the settlers to guess at the probable location of their claims.

(3) The immigration has steadily increased, year by year, until there is an estimated population of nine hundred.

(4) The uncertainty of the location of section lines, yet to be surveyed, causes an earnest desire that the work of completing the survey, be prosecuted as soon as possible.

(5) As these settlers are usually a poor, but thrifty, industrious, law-abiding class of people, many of them veterans or sons of veterans, in their country's service, seeking to secure and improve homes for themselves and their families, they anxiously hope that nothing may be done by any of our public officials, or by the Senate committee, to retard the realization of those cherished anticipations, nor to frustrate their final attainment.

But if, in the judgment of the surveyor-general for Idaho and of the Senate committee, moiety of aid is deemed advisable to be appropriated, without jeopardizing our homes, or entailing burdens by way of future rental expenses, to the people, it would be duly appreciated by the citizens.

Your obedient servant,

S. M. SISK.

BENJ. H. SMITH,
Assistant.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

Summary of Boise County reports.

Ditches.	Length.	Irrigates.	Remarks.
	<i>Miles.</i>	<i>Acres.</i>	
Lake Fork ditch	10	19,200	Begins at head of Lake Fork Creek; constructing.
Gold Fork ditch	10	19,200	Begins far up Gold Fork; ends at the falls; constructing.
Big Creek ditch	2	3,000	Begins at Big Creek.
Clear Creek ditch	2	800	Begins on Clear Creek and goes west.
Tamarack Falls ditch ..	10	20,000	Begins at the falls, on west side; constructing.
Kimball ditch	3	1,200	Begins at Hazard Creek; runs east; completed.
Many private ditches ..	(?)	(?)	Watering from one to one hundred acres.
Total on Long Valley ..	37	63,400	
Garden Valley		5,100	Has had whole valley irrigated for some years.
Squaw Creek Valley		9,000	Is fully irrigated, and has about forty homesteads.
Horseshoe Bend and Squaw Creek Flat		6,000	Are fully irrigated from the river; has thirty homesteads.
		83,500	

Total area of country, 3,024 square miles.

CASSIA COUNTY.

REPORT BY T. A. STARRH.

DEAR SIR: I beg leave to submit the following in reply to the questions asked in your circular letter of June 15, 1899.

Cassia County, with a climate unsurpassed by any Territory in the Union and equaled by few, situated in longitude 37° west from Washington and latitude 42½°, contains 5,100 square miles of land, about one-fourth of it mountainous, with a little timber, one-half undulating grazing lands of great excellence, and one-fourth level and very fertile farm lands. Products: Cattle, wool, horses, hay, grain, vegetables, and fruits. Snake River, Raft River, East Rock Creek, Sublette, West Rock Creek, and Salmon River are its principal streams, thus making it is one of the best-watered counties in the Territory, upon all of which, except Snake and Salmon Rivers, agriculture is successfully carried on, and the entire amount of water these streams produce is used upon the land, except that which runs to waste during the months of January, February, March, and April, which could be held in storage by a system of reservoirs and fully supply the present settlers; and on some streams reclaim thousands of acres that could never be reclaimed in any other way, as the elevation would be such as the advent of a canal from Snake River could not reach them. The past three years have been seasons of continued drought. The past winter much less snow has fallen than has been the case within the knowledge of the earliest settlers, consequently de-

ing the already-depleted streams, thereby reducing very much the annual production of all crops.

It is thought, from the best sources of information we have at hand, that a system of storage reservoirs in this county, at a cost of about \$50,000, located at the heads of the aforementioned streams, would reclaim 10,500 acres of valuable land that never can be reclaimed in any other manner, and furnish water for at least 5,000 acres already settled upon; whereas without such aid the settlers will have to emigrate to some other locality and leave their homes and other improvements. A canal from Snake River, taken out at the proper elevation, say the South Fork of Snake River, would reclaim at least (in this county) 400,000 acres of the very best lands. The cost of said canal would be difficult to estimate until the completion of the surveys, but it is thought would not exceed \$5 per acre for all lands covered by the canal, and it could be extended into the adjoining county on the west (Owyhee) and would cover the Bruneau Valley.

Salmon River Valley, 4,200 feet above the sea, is not under cultivation, but has a fine climate, that adapts it to the raising of hay and grain and all kinds of fruits. This valley is 52 miles long by an average of over 30 miles wide, and contains many hundred thousand acres of fine land. The Salmon River, at a point at Rock Creek Station, has an elevation of 4,200 feet. This river to the west of Rock Creek takes its rise on the eastern slope of the Bruneau Mountains, in the State of Nevada, flows east for some distance, then flows nearly due north a distance of 100 miles, and empties into Snake River one-half mile above Payne's Ferry. It flows through one of the finest bodies of land in the country, but it is in a deep cañon from the time it debouches in the valley 6 miles below the Brown ranche, where it would require an extensive dam to raise it to the level of the land. The material—rock—is very plenty and near by. This would amply repay a liberal expenditure of money to reclaim, as its usual flow far exceeds any stream in the county. Its flow in flood time is equal to 60,000 miner's inches of water. Some 4,000 acres of hay is cultivated upon the upper waters. This valley is capable of sustaining 10,000 people. Number of ditches, fifteen; length of them, 20 miles.

Rock Creek takes its rise upon the northern slope of a spur of the Goose Creek Mountains, flows a distance of 35 miles, and empties into Snake River 33 miles west of Shoshone Falls.

Dividing the county into water districts, we begin with the West Rock Creek and Dry Creek as No. 1, which contains, during the ordinary irrigation seasons, about 3,000 inches of water and about 35,000 acres of valuable farming land. About one-half of it is in a good state of cultivation, producing hay, grain, vegetables, and fruit, yielding per acre—timothy hay, 2½ tons, value per acre \$20; wheat per acre, 40 bushels, value \$24; oats per acre, 50 bushels, value \$15; barley per acre, 45 bushels, value \$13; potatoes per acre, 200 bushels, value \$60; alfalfa per acre, 6 tons, value \$36. Number of ditches in district, thirty; length, 25 miles. There is a very favorable situation for a reservoir at what is termed "The Forks," which could be built for about \$5,000, and would enable those who are now deprived of water to have sufficient and reclaim about 500 acres of land.

Goose Creek, in water district No. 2, takes its rise in Goose Creek Mountains, and first flows in a northeasterly direction, then runs almost due north to Snake River emptying into it about 32 miles east of Shoshone Falls and 5 miles above Starrh's Ferry; contains in ordinary seasons about 12,000 inches of water; it has many small streams that flow into it: Birch Creek, Basin Creek, Trapper Creek, and other small streams. Goose Creek Valley at Oakley has an elevation of 4,440 feet above the sea; at the island 4,341 feet. It contains about 300,000 acres of the finest land in the Territory. It has a length of about 27 miles north and south, and an average breadth of about 20 miles east and west. There are about 14,000 acres under cultivation. The average yield of crops in ordinary seasons is, viz: Wheat per acre, 40 bushels; value, \$25; oats per acre, 50 bushels; value, \$15; barley per acre, 45 bushels; value, \$14; potatoes per acre, 200 bushels; value, \$60; alfalfa per acre, 6 tons; value, \$36; timothy per acre, 2½ tons; value, \$20.

The water supply for irrigation begins to fail about the 20th of June to about one-third of needed supply, but there has not been one-third the amount required this year at any time of the season. About 8 miles up the Goose Creek Cañon, above the mill, there is a very fine location for a storage reservoir.

The bluffs approach on each side of the cañon to within 150 feet, above which an extension flat spreads out of slight grade. A dam built between these bluffs at a height of 50 feet would form a reservoir 2 miles long by three quarters to 1 mile wide and cost about \$12,000. In ordinary seasons there is in Goose Creek above this point 10,000 inches of water. Another very favorable location is on a tributary of Goose Creek called Trapper Creek. With an outlay of about \$15,000 a reservoir could here be built that would be three-fourths of a mile wide by 1 mile long, with an average depth of 20 feet; this location would be desirable, as its depth would prevent a rapid evaporation. On the west side of Goose Creek is a stream called Cottonwood. In ordinary

years this stream flows about 2,000 inches of water until about the 21st of May, when the supply diminishes to about 400 inches. A reservoir at this point could be built at small cost. It is the opinion of many that an outlay of \$20,000 on Goose Creek and tributaries would cause the reclamation of at least 5,000 acres more land than can ever be cultivated without it, besides furnishing water to many who will have to move away unless they can get water. The retention of large bodies of water in reservoirs would cause new springs to burst forth and enlarge and feed the others. There are now five canals running from Goose Creek, with an aggregate length of 40 miles and capacity of about 3,000 inches. The other ditches number about fifty; length, 50 miles; water required to irrigate 1 acre of land of average crop 1 inch to the acre.

District No. 3, Marsh Valley, is situated in the mountains at an elevation of 4,700 feet above the sea at Albion, which is our county seat. The valley is about 15 miles long, its greatest width, at Albion, about 7 miles. Its main streams are Marsh Creek, Land Creek, and Howell Creek and their tributaries. Marsh Creek takes its rise in a spur of the Goose Creek Mountains, the summit of which is Mount Harrison; elevation above the sea, 10,000 feet. In ordinary years the snow falls to a great depth upon this spur of the Goose Creek Range and furnishes an abundant supply of water. Fifteen hundred feet below Mount Harrison is Lake Cleveland, one of nature's natural reservoirs and the main source of Marsh and Land Creeks. Five thousand dollars expended upon this lake would store an area of water covering about 30 acres at a depth of 20 feet above low-water mark. Green Cañon, about 1,500 feet below the lake, is another favorable storage reservoir, and could be built at a cost of about \$5,000. At Cow Gulch, a point where both Summit and Howell Creeks can be utilized, another storage reservoir can be built at a cost of about \$3,000.

The three reservoirs above mentioned would store a sufficient quantity of water to enable every settler upon Marsh Creek and its tributaries to have sufficient water to irrigate all the land claimed and in cultivation by them. Without such aid many will have to leave their homes and improvements. Some few have already done so, migrating to British Columbia, others seeking employment in the mines of this Territory and Montana. Marsh Creek has a length of 17 miles from its source to where it empties into Snake River, 10 miles above the mouth of Goose Creek. The amount of land claimed and fenced along this stream is about 13,000 acres, with about 4,500 acres under cultivation. Number of ditches, ninety; length, 88 miles. Marsh Creek and tributaries have such heavy grades that the waters flow very rapidly during the flood-tide. In ordinary years there flows into Snake River for the months of January, February, March, and April the largest body of water that runs in the streams during the year. It is calculated that the flow of the waters of Marsh Creek amount to 15,000 inches under a 4-inch pressure, thus furnishing, if stored in reservoirs, sufficient water to irrigate all the lands claimed and under cultivation. After the 4th of July this stream is reduced to almost nothing. At this elevation corn is produced and all the fruits, apples, pears, plums, cherries, and small berries in the greatest abundance with surpassingly fine flavor. Yield of crops in ordinary years: Wheat, per acre, 45 bushels; value, \$27. Oats, per acre, 55 bushels; value, \$17. Barley, per acre, 45 bushels; value, \$15. Corn, per acre, 35 bushels; value, \$13. Potatoes, per acre, 250 bushels; value, \$45. Alfalfa, per acre, 6 tons; value, \$36. Timothy, per acre, 24 tons; value, \$20.

Cassia Creek, in district No. 4, takes its rise at the base of Mount Independence, at a point where the general trend of the Goose Creek Range trends to the west. At an elevation of 10,500 feet above the sea, its summit, in ordinary years, is white with snow until in August. It is fairly covered with timber and its sides deeply furrowed with ravines, which prevent the sun from melting the accumulated snows which drift into these ravines in the winter to a great depth. This is the main reason why Cassia Creek furnishes the largest and most continuous volume of water in the county for its size. Its volume in the three spring months is equal to 15,000 inches of water, and at times to 20,000 inches, but diminishes very much by the 1st of July. This stream, from Mount Independence, flows almost due east a distance of 12 miles and empties into Raft River, near the center of the town of Malta, at Conant's store. The valley has an elevation of 4,700 feet above the sea. Near the base of Mount Independence are three natural depressions, or small lakes, with an area of about 20 to 25 acres (the depth varying from 15 to 20 feet), which would make three reservoirs, each at a cost of about \$10,000. There are other favorable locations where reservoirs could be built, lower down on the stream, at a reasonable cost. The storage of water at this elevation would furnish water for all the available lands on Cassia Creek, and some bench lands below the junction of Cassia Creek and Raft River, which, without such aid, will probably never be reclaimed. Amount of land owned and fenced, 5,100 acres; amount under cultivation, 2,200 acres; number of irrigating ditches, fifty-six; length, 45 miles.

Average yield and value of crops in ordinary years, viz: Wheat, per acre, 45 bushels; value, \$26. Oats, per acre, 56 bushels; value, \$17. Barley, per acre, 45 bushels;

value, \$16. Corn, per acre, 30 bushels; value, \$13. Potatoes, per acre, 250 bushels; value, \$45. Alfalfa, per acre, 6 tons; value, \$20. Timothy, per acre, 2½ tons; value, \$20.

Almo Creek, altitude about 5,000 feet, in district No. 5, takes its rise in a spur of the Goose Creek Mountains, to the west and south of Mount Independence, and flows almost due south into Raft River. There is a fine site for a reservoir at the head of the stream, which would reclaim 400 acres of fine land and enable those already settled there to have sufficient for their wants. Amount of land in cultivation, 600 acres; average production per acre and value the same as Cassia Creek.

Raft River Valley, in district No. 6, one of the most extensive valleys in the county, has a length of 45 miles, average width of 11 miles. There are about 300,000 acres of land susceptible of cultivation; altitude at the bridge, 4,650 feet above the sea. Raft River has a flow of about 15,000 inches in ordinary years until July, when the supply diminishes very much. The South Fork of this river takes its rise in Utah Territory, at the southwest end of Junction Valley, in a spur of the Goose Creek range of mountains. The North Fork takes its rise in the Goose Creek Mountains, in Idaho. These forks form into one stream at what is called the narrows; from its source this stream flows east about 20 miles, then runs nearly due north, emptying into Snake River 9 miles below Fall Creek, at Bonanza Bar.

There are a number of fine locations for reservoir sites. The best one would be upon the South Fork at the south end of Junction Valley. It would require at least about \$20,000, but the result would justify the outlay, as it would form a lake some 3 miles in length to 1 mile wide, and any desired depth, according to height of the dam. The same could be done at the North Fork, so the amount of land to be reclaimed by the two reservoirs mentioned would depend upon the heights of the dams at each reservoir. The altitude would be about 4,980 feet above the level of the sea; amount of land owned and fenced, 15,000 acres; amount under cultivation, 6,500 acres. Number of ditches, sixty; length of them, 70 miles. Average yield of crops, viz: Wheat, per acre, 45 bushels; value, \$26. Oats, per acre, 55 bushels; value, \$17. Barley, per acre, 45 bushels; value, \$16. Corn, per acre, 30 bushels; value, \$13. Potatoes, per acre, 250 bushels; value, \$45. Alfalfa hay, per acre, 6 tons; value, \$30. Timothy hay, per acre, 2½ tons; value, \$20. Natural hay, per acre, 1½ tons; value, \$9.

Raft River, like all other streams in the county except Sublette Fall Creek and East Rock Creek, takes its rise in the Goose Creek Mountains or spurs of the same. At the sources of the streams their altitudes are very nearly equal and the annual snow and rain fall very near the same, furnishing a uniform amount of water very nearly supplying the wants of the settlers until the 25th of June or 4th of July, when the supply diminishes very rapidly.

District No. 7: Clear Creek, a tributary of Raft River, takes its rise in the Clear Creek Mountains in Utah Territory, and flowing nearly due north a distance of 30 miles, empties into Raft River a short distance below the bridge. It has much valuable land and has an elevation of 4,700 feet above the sea. Land in cultivation, 3,000 acres, principally in hay. Number of ditches, twelve; length, 20 miles. Clear Creek contains in average years of snow-falls about 5,000 inches of water during the early part of the season, and diminishes to a very small stream after the month of July. There is a favorable site for a reservoir at the mouth of Clear Creek Cañon. Five thousand dollars would build a reservoir that would store sufficient water to reclaim 1,000 acres more land. The Clear Creek Mountains are a lofty mountain range 9,000 feet above the sea, and in ordinary years the snow falls to a great depth in the cañons and on its summits.

District No. 8: Sublette is a fine mountain stream, takes its rise in the Sublette Mountains, and flows for a distance of 12 miles to the west and empties into Raft River a short distance below the town of Malta, at the mouth of the cañon. Two reservoirs can be built at a cost of about \$5,000. That, it is thought, would store sufficient water to reclaim 400 or 500 acres of very fine land. Altitude above the sea, about 4,750 feet. There is under cultivation about 400 acres of land in grain, hay, etc. Value per acre and quantity about the same as that of Raft River, of which it is a tributary. It has an ordinary flow of 600 inches of water until about the 1st of July, when, like all the other streams, the supply diminishes.

Hagler Creek in district No. 9, a short distance to the north of Sublette, takes its rise in the same mountain range and flows almost due west for 11 miles into Raft River. This, though a small stream in the spring months, furnishes a fine body of water until June 20, when it becomes quite small. The mouth of this cañon, called Hagler, affords a fine site for a reservoir, which could be built at a small cost. No land under cultivation on this stream.

Fall Creek, in district No. 10, is a fine mountain stream of tepid water, takes its rise on the western slope of a spur of the Bannock Mountains; flows into Snake River at Bonanza Bar, and is used for placer mining. No land suitable for cultivation.

East Rock Creek, situated a few miles east of Fall Creek, takes its rise in the same range of mountains, is a strong mountain stream only a few miles long, empties into Snake River 2 miles above Bonanza Bar. The land is cultivated to a limited extent,

and it is also used for placer mining. A reservoir can be built in the cañon at small cost that would reclaim all the land near the Snake River, about 300 acres.

The streams of Cassia County, except Salmon, Sublette, East Rock Creek, and Fall Creek, take their rise in the Goose Creek Mountains and spurs thereof. The altitude where the streams take their sources is very near equal to the usual fall of snow and rain in ordinary years, and effect each about the same. It has been impossible to obtain any exact data in regard to the annual snow and rain fall, as there never has been any post of observation where such knowledge could be obtained. The only way to arrive at any approximate conclusion is by noticing the rise of the streams during different years. During what is termed "good years" all of the streams at flood tide, sometimes February, generally in March and April, have had a flow of about three times as much as the usual flow. In fact, it is generally the case, for the three years last past have been noted as amongst the poorest for at least fifteen years, this year being the most trying of all. Snake River this year is the fair indication of the falling off in the water supply, and would be a fair sample of the streams in our county.

At Starrh's Ferry (altitude 4,075 feet above the sea, 5 miles below the mouth of Goose Creek), Snake River is 800 feet broad. Its usual rise at this point is 5.5 feet; its unusual rise is 6.5 to 7 feet. The rise begins a month later, say April, than in the other streams of the county, and lasts until about the 1st of August. As a rule at its greatest height about the 10th to 20th of June, at which time the other streams begin to fail. Snake River's rise this year was only 2 feet, and began to fall again by the 1st of July.

During a residence of fifteen years in this county I have very often seen, in the months of March, April, and May, the different streams carrying unusual quantities of water. Salmon River over 100,000 inches of water; Rock Creek, 10,000 inches; Dry Creek, 6,000 inches; Goose Creek, over 30,000 inches; Marsh Creek and Cassia Creek the same; Raft River at least 40,000 inches, the balance in the same proportion. So it will be seen at once no more desirable location, could be asked than we have in this county for the storage of water; and as a rule, we have had the water to store, but it ran into Snake River before it could be used; and the result has been when it was needed there was not enough. The duty of the water varies according to the kind of soil, the variety of crops, and the length of time the soil has been cultivated. One inch of water to the acre is needed for new land, and some soil will absorb more for the first two years. The irrigating season begins for hay about the 15th of April to the 1st of May, and for grain from the 1st of May until the 15th of July. The irrigating season for grain lasts sixty days. Alfalfa requires irrigating after the first crop, say 20th of June; and again after the second crop, say 15th of August, one good irrigating being sufficient to produce a fair crop. Small fruit and fruit-trees require water about every ten days, two "irrigatings" is considered ample to produce a good crop of potatoes. Three "irrigatings" are sufficient to mature grain crops, especially so, if the land has been cultivated for two years. Lands where the hard pan is 24 inches below the surface, when once saturated to that depth, produce better crops and require less water than when the hard pan is only 15 inches from the surface. I am indebted to Mr. Frank Riblett for corrections upon the altitudes at different points. I have also consulted with our county surveyor, Charles Chapin, whose map and my report correspond very closely on all material facts stated in the foregoing.

Very respectfully, yours,

T. A. STARRH.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

REPORT BY A. B. ROBERTS.

BASIN, CASSIA COUNTY, IDAHO, *July 29, 1889.*

DEAR SIR: As I learn you are collecting information on the subject of irrigation and the storage of water, etc., for the Senate committee, I thought that a little item from this locality might be of interest from one who has some knowledge and experience in connection with the subject.

I will describe our location, which is on Goose Creek, about 6 miles above Oakley, where there is a cañon about 500 feet high on each side, above which the valley widens out to about a mile and is quite level, so that from a distance of 3 or 4 miles are large meadow-lands. At this point water could be stored for irrigation at a cost not to exceed \$1.50 per acre for the amount of land susceptible thereon, I think. As fine stone for construction of a dam is at hand, this place is a very desirable one. The water-shed which would furnish this reservoir is very extensive. The lands below are very fine and so situated that they are easily irrigated, and of a character that requires the minimum amount of water for raising a crop, and are in a good

climate for producing all of Idaho's best products. The body of land available is unlimited.

I am acquainted with several other places where I have, during the last few years, looked out sites for storing water and figured upon the cost in the matter; and if any such information from me would be desirable I might give you some more items.

Yours, respectfully,

A. B. ROBERTS.

Governor GEO. L. SHOUP.

REPORT BY FRANK RIBLETT, CIVIL ENGINEER.

BOISE CITY, IDAHO, *August 15, 1889.*

SIR: In compliance with your request I report the following items relating to the systematic and thorough construction and maintenance of reservoirs and canals in southern Idaho, particularly in Cassia County. Since our committeeman, Mr. T. A. Starrh, made his very able and comprehensive report, large reservoir sites have been reported near the head of Cedar Creek, Trapper Creek, Rock Creek, Goose Creek, and Basin Creek; also at the forks of the Sublette and other places where large bodies of water could be stored at moderate cost. Numerous favorable sites can be found all over the county, and no doubt the entire flood volume of the Cassia County streams can be stored in these places. Materials for construction are everywhere convenient, labor is not high, evaporation and "seepage" would not be excessive, foundations, abutments, and places for waste river or overfall are the very best. Contrary to the general belief these mountain basins would hold water comparatively well. The bottoms are composed of gravel, sand, and impervious clay.

The foundation of the shore slopes would generally be similar, although in some cases it would be mixed with some float, bowlders, and rock, and in other cases would be a lava precipice. But even where bounded with escarpments there is no great danger, for the fractures or seams of this rock in the mountains are generally filled with a hard cement or other impervious material; but seepage is not so objectionable, for the largest percentage of the water escaping in this way would burst out in springs below where it could be used for irrigation. Where water for irrigation is abundant it finds its way back into the original channel by percolation again and again, where it can be used for irrigation several times.

In Idaho, as well as in other irrigating countries, after a term of years the ground becomes more or less saturated with water and acts as a storage reservoir, keeping up the supply of water late in the season. This has been practically shown on Goose Creek, Raft River, and other streams in Cassia County. Reservoirs and ditches lose less from year to year.

On the deserts, in the spring of the year, are found many natural lakes or ponds; some of these are perennial, others having a depth of from 3 to 5 feet disappear with the advance of the season, indicating about that depth of evaporation and "seepage" for three months. Again these factors of loss would be partially compensated for by waste water, ordinarily flowing into the reservoirs during the winter months. The waste-weir or overfall can always be conveniently made separate and apart from the main dam, a consideration of no little magnitude. The foundations can with no very great amount of excavation be placed on the everlasting bed rock.

I will mention a typical reservoir on Goose Creek: near the corner to townships 14 and 15 south, of ranges 21 and 22 east, is a basin with an area of about 900 acres having its outlet in a very narrow gorge. A dam having a length at the bottom of 30 feet and at the top of 200 feet, with a height of 140 feet, would cover this basin with an average depth of 100 feet of water. All materials for construction except timber are found in abundance on the location. Timber would have to be hauled from 6 to 10 miles. Above this site a few miles is another nearly as good, and still farther up, across the Territorial line, is the grandest site of all, said to be 6 miles in length by $1\frac{1}{4}$ in width, having a narrow outlet in which a dam 200 feet high could be constructed at a cost not exceeding that of the location first mentioned; but this upper place I have never seen and could not vouch for. It is in Nevada and the land is said to be private property. The dam first mentioned could be constructed for \$100,000, and the reservoir would probably furnish water for the irrigation of 40,000 acres of land.

At many other reservoir sites in Cassia County timber would be much more convenient. The reservoir sites on Cottonwood Creek, Cassia Creek, Marsh Creek, and other places have been mentioned by Mr. Starrh.

The duty of water varies, but averages about 100 acres per second-foot where land has been brought under complete cultivation. The first two years will require more. The water sheds of Cassia County streams vary in character. Salmon Creek, Cedar Creek, Cassia Creek, Marsh Creek, and some other streams head in high snow ranges,

while Goose Creek and others either head on low mountains or table lands. The Goose Creek catchment basin in Idaho, Utah, and Nevada, although comparatively low, is very extensive, covering about 1,000 square miles of territory upon which the average depth of well packed snow and ice, at the close of an ordinary winter, is estimated at from 3 to 4 feet by trappers, hunters, and stockmen residents in the country. This snow and ice would probably average one-half water. In an average season the total flow of the flood waters of the Cassia County streams can not be less than 45,000,000 cubic feet; of this amount Goose Creek would furnish about one-ninth. This would be sufficient for the irrigation of 500,000 acres of land; 300,000 acres of this amount would be above the line of any Snake River canal.

As a canal from Snake River would irrigate 700,000 acres, a grand system of canals and reservoirs would irrigate at least 1,000,000 acres in Cassia County at an expense of less than \$5 per acre. This by no means exhausts the arable lands of this magnificent section, for large areas of fertile lands more elevated than the main valleys, ranging from 5,000 to 6,000 feet elevation, may yet be reclaimed by artesian wells and water pumped by mechanical appliances. In the grand work of irrigation, the transmission of electrical power for the running of improved pumps may yet bear its part. As the county becomes older the duty of water will increase and other factors will spread the area of cultivated lands, until the great American desert will exist only in history. Pardon this digression; I promised to confine myself to facts.

On the 22d day of July, 1889, Snake River, at Story's Ferry, stood 2½ feet below ordinary low-water mark, 13½ feet below ordinary high-water mark, and 16½ feet below maximum high-water mark. On said date I assisted Mr. E. B. True, civil engineer and United States deputy mineral surveyor, to measure the said stream. We estimated it at 5,500 second-feet. In high water, with added depth, width, and velocity, it might exceed 50,000 second-feet.

Among other enterprises, I will mention that of a proposed canal from Snake River, heading at Story's Ferry. This enterprise (a private one) dates back to January, 1880, at which time I ran a few lines and levels and, with others, made location of water-right and ground. At subsequent times I made further investigation and joined with others in locations. This was kept up for eight years, with results generally unsatisfactory. In the summer of 1888 we learned we had one of the very best sites for an immense dam, of a kind that could be constructed at a reasonable cost. This was the "key to the situation." A full reconnaissance of the ground was made, full and complete notices of location of water-right and ground were posted and recorded. A local association, known as the Snake River Land and Canal Company, was organized and efforts resumed. Up to the present time said company has done representative work to the amount of from \$3,000 to \$4,000. At present the intention is to raise the river 37 feet at a point about three-fourths of a mile above Story's Ferry. Here one canal will be taken out on the north side, irrigating about 85,000 acres in Logan County, and another on the south side, irrigating about 15,000 acres in Cassia County, besides developing hundreds of placer claims and immense water-power, at a cost of less than \$400,000. Having sufficient fall, it is the intention to run a line of levels to Shoshone, county seat of Logan County; also, down Snake River on both sides.

If these lines should prove feasible much more land can be covered and placer claims developed. In regard to reservoir sites in counties lying adjacent to Cassia, including Logan, Oneida and Owyhee, I say this: that their topography is fully as favorable as that of Cassia County. In connection with this and other matters, I refer you to my report made on the preliminary survey of the Great Snake River Canal in January, 1888; also to an additional report submitted the following spring. These reports were published in the Cassia County Times and other papers. While thorough surveys will be required to ascertain the feasibility of a system of reservoirs for the storage of the surplus waters of the small streams, as compared with a system of canals from Snake River, still it is the opinion of the majority of our citizens that moderate appropriation for reservoirs, made in the near future, would be advisable. Some steps should be taken for the relief of citizens who have taken up and brought under cultivation large areas of the public domain, whose lands are now subject to destructive droughts three years out of ten.

Very respectfully,

JOSEPH C. STRAUGHAN,
United States Surveyor-General.

FRANK RIBLETT,
Civil Engineer.

Summary of Cassia County reports.

Localities.	Lands.		Ditches.	Length.	Amount of water flowing.	Remarks.
	Irrigated.	Irrigable.				
<i>District No. 1.</i>	<i>Acres.</i>	<i>Acres.</i>		<i>Miles.</i>	<i>Inches.</i>	
Rock Creek and Dry Creek.	17,500	17,500	30	25	3,000	A reservoir at "the forks" would supply present deficiency and reclaim 5,000 acres additional.
<i>District No. 2.</i>						
Goose Creek.....	14,000	300,000	50	50	12,000	A dam 150 feet long, 50 feet high, costing \$12,000, would form a reservoir of 1,000 acres; another good site on Trapper Creek, costing \$15,000, would add 5,000 reclaimed and supply present deficiency. Settlers are leaving this valley on account of drought.
<i>District No. 3.</i>						
Marsh Valley.....	4,500	27,000	90	80		Is 15 miles long and at Albion 7 miles wide; elevation, 4,700 feet. Cleveland Lake (8,500 feet) for a reservoir, costing \$500,000, would cover 30 acres 20 feet deep. Good sites for water storage are also on Mark Green and Cow Gulches. Settlers are leaving this valley on account of drought.
Fenced.....	13,000					
<i>District No. 4.</i>						
Cassia Creek.....	2,200	10,000	56	45		Has three good locations for reservoirs, each of 20 to 25 acres, 15 to 20 feet deep, costing in all \$10,000.
Fenced.....	5,100					
<i>District No. 5.</i>						
Almo Creek (5,000 feet).	600	400				Has good site for a sufficient reservoir.
<i>District No. 6.</i>						
Raft River (4,650 feet).	6,500	300,000	60	70	15,000	Has two sites for reservoirs (4,980 feet), each covering 2,000 acres and costing \$20,000 each.
Fenced.....	18,000					
<i>District No. 7.</i>						
Clear Creek (4,700 feet).	2,000	1,000	12	20	5,000	Site for one good reservoir; now has water enough until middle of July. Chief crop, hay.
<i>District No. 8.</i>						
Sublett Creek (4,750 feet).	600	500			600	Has sufficient water until July 20; \$5,000 would build two small reservoirs, sufficient for this valley.
<i>District No. 9.</i>						
Hagler Creek.....						Has a good site for small reservoir; no cultivation reported.
<i>District No. 10.</i>						
Fall Creek and East Rock Creek.						Small, rapid mountain streams used chiefly for placer mining at Bonanza Bar, on Snake River; about 300 acres might be reclaimed by a small reservoir.
	82,000	654,400	298	299		

* Canals, 5; miles, 20.

RECAPITULATION.

Land irrigated.....	acres..	82,000
Land irrigable.....	do.....	654,400
Number of canals and ditches.....		298
Length of canals and ditches.....	miles..	299

Altitude from 4,500 to 5,000 feet above the sea. Area of the county, 5,100 square miles or 3,264,000 acres. One-half undulating; good grazing. One-quarter level; good farming. One-quarter high mountain; much snow.

Field per acre.—Wheat, 45 bushels, \$27; Oats, 55 bushels, \$17; barley, 45 bushels,

\$15; Corn, 35 bushels, \$13; potatoes, 250 bushels, \$65; alfalfa, 6 tons, \$36; timothy, 2½ tons, \$20.

Fruits abundant and very fine.

Salmon River Valley (average altitude 4,200 feet) has nearly 1,000,000 acres now desert. The land is very superior.

CUSTER COUNTY.

REPORT BY L. H. JOHNSTON.

I am unable to give a correct description of the land in Custer County, Idaho, that could be made profitable for farming by having water conveyed upon it. The information I have obtained has been given me by the settlers of the different valleys. Pahsamaroi has the most agricultural land of any of the valleys, and is the best watered of any by natural streams; but many of the streams emptying into this valley sink in a short distance after leaving the mountains, creating small sections of choice farming land where the streams sink; but there is a large part of the bench land which it is impossible to cultivate, unless the water is diverted from the present channels.

Where the streams leave the mountains the cañons are narrow and steep, so that reservoirs at the mouth of the cañons would hold but small quantities of water.

Lost River Valley, in the southern part of Custer County, is similar in its character to Pahsamaroi Valley, excepting that in ordinary seasons Lost River sinks in places and rises again lower down the valley.

Antelope Valley has no stream of any size at the head of the valley.

Salmon River passes through Round Valley, and carries sufficient water for irrigating all the land in the valley, even at the lowest of stage of water; but portions of the bench land lie so high that the taking out of the water costs more than individuals are able to expend.

There are no sites where I could recommend the building of reservoirs, but I think some 10,000 acres of land could be reclaimed in Lost River Valley by the digging of a canal and diverting the water from the present channel, thus carrying it along the bench higher up the valley, and about the same quantity of land might be reclaimed in Pahsamaroi Valley, about 5,000 acres also in Round Valley.

There is no county surveyor in Custer County, and I could not give any estimate as to what these canals would cost, but I am informed that a great portion of the work, in both Lost River and Pahsamaroi Valleys, could be done with plow and scraper.

Very respectfully, etc.,

L. H. JOHNSTON,
Challis, Custer County, Idaho.

ELMORE COUNTY.

REPORT BY ELMER C. TOWNE.

ROCKY BAR, IDAHO, July 8, 1889.

SIR: In answer to your circular of June 8 referring to irrigation and water supply, I would respectfully submit the following:

Nearly all of Elmore County situated north of the "base line" is mountainous, the people devoted to mining pursuits, and the area adapted to agriculture limited.

I have personally examined the country along the Big Smoky and South Boise Rivers to the junction with the main Boise, and find along said streams bottom and low bench land, the soil of which is well adapted to the growing of all agricultural products common to this altitude in Idaho. Twenty thousand acres can be irrigated from these streams at an estimated cost of \$10,000. No practicable site for any storage reservoir was found, and the water supply is sufficient for all the land that can well be covered by canals or ditches from these streams. Could Government aid be obtained for constructing the main canal the expense connected with all lateral ditches could easily be borne by settlers.

These lands would then become very valuable, as their close proximity to the mines insures a good and permanent market.

I had intended making a report upon the lands adjacent to and bordering on Snake River, but I have been informed that E. C. Helfrich, esq., of Mountain Home,

has already made a report upon the same, and he being familiar with that section of the country (while I am not) would doubtless best understand its wants and requirements.

Most respectfully, yours,

ELMER C. TOWNE,
United States Deputy Mineral Surveyor.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

REPORT BY E. C. HELFRICH.

MOUNTAIN HOME, IDAHO, July 11, 1889.

DEAR SIR: Your circular of June 15 received. I have conversed with many of our citizens in this county on the irrigation topic, and only one suggestion is made or offered, namely: The Great Snake River must be taken out from the eastern part of the Territory if the lands of southern Idaho are ever cultivated.

The South Boise River passes through part of Elmore County, but does very little benefit. The lands that are irrigated therefrom are located high in altitude, and only hay and a few vegetables can be raised, and to bring this river to cover the lands in this vicinity would cost an enormous amount of money.

The area of land tributary to Snake River in this county is 450 square miles, and there are fully 210,000 acres of good farming land. To give you an idea of the Snake River in the very lowest, it is 550 feet wide and 30 feet deep on an average, and has a good steady fall; and at the same time when the water is the highest is the very time when the irrigation would be wanted, providing a canal were made and water thus taken from the river. As it now remains no one has any value from this stream, as its banks are high above the water.

The land and climate of Snake River Valley can not be excelled anywhere. They will produce anything that can be raised in this country if water is brought thereon.

Five years ago Mr. Frank Ake located on a one-fourth section 3 miles from here in the very heart of the sage brush. He cleared it off, set out fruit trees and berry and grape vines, as well as alfalfa. Being located near a creek he made a ditch and covered the spot with water, and to-day that ranch is a model place. The trees are loaded with fruit and his vines with grapes; but the creek is now dry, the first time that we can remember or can hear of. Other nice homes are near by, but are unable to have water, and this year being one of drouth makes it hard on all the persons who are not favored, and there are very, very few who can say they are amply supplied with water.

Take the ranch of Charles Howeth, 18 miles from here; he has living springs on his place, and on 50 acres he cuts alfalfa four times a year and 2 tons at each cutting to each acre. This is the effect of plenty of water; and all our land is in the same condition if water could be had thereon. Also refer you to Frank R. Coe's ranch, where springs abound and there is hay in abundance.

We have numerous ranches within a radius of 20 miles, but they depend upon the creeks that come from the mountains, and as no water came this spring all are suffering; not even a reservoir could be filled this past spring, so that all of our people look forward only to the great relief, and that is a canal from Snake River, where water never falls.

Storage reservoirs will be uncertain, judging from the past winter, as far as Snake River Valley is interested and depending on them is concerned. We have no ditches or canals in this county, for we could not secure water from Snake River except by building 250 miles of canal, and that we are not able to do. This statement also applies to South Boise River, where we would be obliged to tunnel through the mountain, although the river is not over 30 miles from us, with ample fall to cover miles of this valley.

This county is completely on the desert and our only hopes for the future are in the Government aiding us, for certainly the money is not here to do the work that is required; but the land is here to pay for it as soon as a canal is completed, even if the price is made at \$10 per acre with water.

I remain, yours respectfully,

E. C. HELFRICH.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

SUMMARY OF ELMER COUNTY REPORTS.

[Compiled from reports of Elmer C. Towas, United States deputy mineral surveyor, and Hon. E. C. Helfrich.]

In this county, about 12 miles southwest from Rocky Bar, there is found locations for five reservoirs, with a gross capacity of nearly 1,000,000,000 cubic feet of water.

These reservoirs are tributary only to the South Fork of Boise River and can not serve to irrigate any of the irrigable lands of this county. But they would abundantly re-enforce Boise River and render it absolutely sufficient to irrigate the 900,000 acres in Ada County, if the plan should be found cheaper than by the extension of the great Snake River Canal.

To Mr. A. D. Foote we are indebted for the discovery of these reservoir sites, and for the survey sufficient for an accurate estimate of their capacity and cost.

Boise River will some day be called upon not only to irrigate its half million acres of land, but also to wash out every extensive placer grounds near its mouth on Snake River.

For this reason the following is extracted from Mr. Foote's report, viz:

Discharge of Boise River at Foot's Cañon; averaged for five years.

January, 1,200, varying to 1,500, cubic feet per second.
 February, 1,200, varying to 1,500, cubic feet per second.
 March, 1,500, increasing to 5,000, cubic feet per second.
 April, 5,000, increasing to 15,000, cubic feet per second.
 May, 15,000, increasing to 30,000, cubic feet per second.
 June, 30,000, decreasing to 10,000, cubic feet per second.
 July, 10,000, decreasing to 3,000, cubic feet per second.
 August, 3,000, decreasing to 1,200, cubic feet per second.
 September, 1,200, varying to 2,000, cubic feet per second.
 October, 1,200, varying to 2,000, cubic feet per second.
 November, 1,200, varying to 2,000, cubic feet per second.
 December, 1,200, varying to 2,000, cubic feet per second.

At the points selected for the reservoirs I found the peculiarities of a former lava flow have rendered the construction of enormous reservoirs a matter of trifling expense, compared with the cost usual for such structures elsewhere.

The lava is in the form of immense dikes across the valleys, in some places resembling the work of man, through which the creeks have broken narrow channel-ways. It is only necessary to fill up these channels with earth, which is abundant and near at hand, thus raising the water until it shall flow over the lava walls for its indestructible waste-weirs.

Table showing estimated capacity, cost, and value of reservoirs located on the upper waters of Boise River.

Name of reservoirs.	Capacity in cubic feet.	Days' supply at 1,000 cubic feet per second.	Capacity in 24 hour 4-inch miner's inches.	Cubic yards in dam.
Upper Fall Creek.....	522, 720, 000	6.05	290, 400	76, 883
Lower Fall Creek.....	418, 176, 000	4.84	232, 220	51, 569
Smith Creek.....	1, 672, 704, 000	19.36	929, 280	69, 164
Upper Blind Creek.....	6, 690, 816, 000	77.44	3, 717, 120	241, 667
Lower Blind Creek.....	313, 632, 000	3.63	174, 240	94, 696
Total.....	9, 618, 048, 000	111.32	5, 343, 260	585, 906

Total area of county.....	square miles..	2, 700
Land irrigated.....	acres..	10, 000
Land additional irrigable.....	do ..	230, 000

IDAHO COUNTY.

REPORT BY A. F. PARKER.

GRANGEVILLE, IDAHO, June 17, 1889.

My DEAR GOVERNOR: Referring to yours of June 8, conferring appointment upon me to gather information relative to irrigation, etc., I beg to say that our area of agricultural land is so limited and so situated that irrigation in Idaho County is not

a factor in our wealth, present or prospective. Our principal agricultural settlement, Camas Prairie, is situated on the summit of the low divide between Clearwater and Salmon Rivers, and as these streams run through great cañons, at least 2,000 feet below us, you will readily perceive the impracticability of bringing water thereon.

Moreover the rain-fall here is usually sufficient for all agricultural purposes.

Salmon River seems to be the dividing line between the arid and moist belts of Idaho.

The subject of irrigation is altogether out of our jurisdiction in Idaho County, but if I can be of use, please command me.

Very truly, yours,

A. F. PARKER.

REPORT BY E. C. SPEDDEN.

GRANGEVILLE, IDAHO, *July 14, 1889.*

DEAR SIR: Your circular letter to United States deputy mineral and county surveyors was received on the 4th instant.

After making considerable inquiry concerning the land which is adaptable to irrigation in this county, I have concluded there is none worth reporting to the Senate committee.

Respectfully, yours,

E. C. SPEDDEN,
County Surveyor, Idaho County.

J. C. STRAUGHAN,
Boise City, Idaho.

LOGAN COUNTY.

REPORT BY HON. JOHN HAILKY.

STANTON, LOGAN COUNTY, IDAHO, *August 4, 1889.*

DEAR SIR: By request of Governor George L. Shoup I herewith send you answers propounded in your circular of June 15, 1889, in reference to irrigation of arid lands, etc., in the northern and northeastern portions of Logan County.

I regret very much that my time has mostly been taken up attending to other matters, and have not, therefore, been able to give this subject the thorough examination its importance demands. I have made some personal examination and inquiry on Camas Prairie, on Big and Little Wood Rivers, and on Silver Creek.

This being an unusually dry season, on account of very little snow or rain having fallen either in the valleys or mountains near here for the past eighteen months, I find most of the streams that usually afford a generous supply of water for irrigating purposes are dry, and have been for several weeks past. The only stream that appears to have kept up its usual amount of running water is Silver Creek, which is fed entirely from springs breaking out in numerous places in the valley south of Bellevue and between the two Wood Rivers. Silver Creek empties into Little Wood River; in fact it furnishes most all the water of Little Wood River below its junction in the dry season of each year.

About the 1st of July I went, in company with Mr. L. D. Hopson, of the U. S. Geological Survey, to a point on Silver Creek below where all its tributaries come together, and there Mr. Hopson measured the flow of water and found it to be 176 cubic feet per second, or about 8,468 miner's inches.

I was at the same place again yesterday and could discover no change in the quantity of water. From the point of measurement to its junction with Little Wood River is about 8 miles, and but little of the water from this point down is used, it mostly going into Wood River, and the greater portion of it is lost in the lava before it reaches the agricultural lands further down the river. This, I think, might be remedied by proper work being done on the bottom of the channel where it crosses the lava, by filling all cracks and leaks.

Big Wood River has only furnished a very limited supply of water this season south of Bellevue, where it is mostly needed. The bed of this stream is washed out in holes in many places, where there appears to be nothing but boulders and coarse sand, and the water runs through and is lost. I think the bed of this stream could be improved so as to save the water from loss, all of which is very much needed. At this time there are several thousand inches of running water in this stream at and above Bellevue; but a few miles south, where water is needed most, it is entirely dry, and has been for a month.

On Camas Prairie there are numerous small streams coming down gulches from the mountains on the north, and crossing the prairie to the south, flowing into what is commonly called Camas Creek, which empties into Wood River. But these streams are all dry, or nearly so, this season.

Referring to the matter of storing up water in reservoirs for irrigation purposes, there are several streams here on which this experiment might be tried at reasonable expense with a fair prospect of good results. Among the most favorable places I have seen to try the reservoir experiment is at the foot-hills on Soldier Creek about 3 miles north of the village of Soldier.

I think, however, that it would be well for Congress to try the experiment of boring artesian wells for irrigation; if it were shown that artesian wells could be sunk with a good strong flow of water and at reasonable expense, private enterprise would take hold and much of the arid land that can not be reached by water from streams would be reclaimed and farms made for many poor families. I respectfully recommend that Congress make an appropriation to defray the expenses of sinking several artesian wells in Idaho, as there are favorable localities in this county where water, if sunk, could be utilized for good purposes. I recommend that one such well be sunk near the foot-hills between Soldier and Corral Creeks on Camas Prairie; that one be sunk at the foot-hills about 7 miles southeast of Bellevue; that one be sunk on what is known as the "burn," between the two Wood Rivers, about 20 miles south of Bellevue. Here lies one of the most beautiful strips of good land in Idaho. It is about 15 miles long, north and south, and in width it ranges from three-fourths of a mile to 3 miles, and has an almost perfectly smooth surface with a slight down grade to the south. All that is wanting on this to make fine and cheap homes is water. Although the lava comes up on both sides there is no rock on this strip, the once heavy sage brush has been burnt up entirely, and it is all ready for the plow if water could be had for irrigation.

While on Camas Prairie a few weeks ago I met Hon. W. Y. Perkins, who resides near Soldier and is engaged in farming, stock-raising, etc. He, at my request, has sent me a letter giving some valuable information in reference to irrigation on Camas Prairie. His letter is hereto annexed, and I recommend that you give it due consideration.

Very respectfully,

JOHN HAILEY.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

[Answers to questions preposed in surveyor-general's circular of June 15, 1890.]

Answer to first question: On Big and Little Wood Rivers, Silver Creek, Spring Creek, Rock Creek, Willow Creek, Elk Creek, Soldier Creek, Corral, and some other smaller streams, to only a limited extent.

Answer to second question: On the streams mentioned above to a very much larger extent than at present.

Answer to third question: Water usually, in ordinary seasons, begins to decrease in most of the streams about the 15th of May; this year very much earlier. Some sites for reservoirs; other places the beds of streams might be improved so as to stop "seepage," while in other places artesian wells may be sunk. There is of good land that could be irrigated with a reasonable expense between the towns of Bellevue and Shoshone, along and between the two Wood Rivers; in a distance of 15 miles width by 50 miles length, at least 125,000 acres; and on Camas Prairie there is about 200,000 acres of good land which can be irrigated with reasonable expense and made very productive.

At present, not to exceed one-tenth of the amount named here has been reclaimed by irrigation or put into cultivation.

There is probably about 120 miles of ditches in and about the two Wood Rivers between Bellevue and Shoshone, covering perhaps 18,000 to 20,000 acres of land, and nearly the same amount on Camas Prairie.

SOLDIER, IDAHO, July 16, 1890.

DEAR SIR: I was called away from home a few days after you were here, and on that account have not made a summary of the information you requested me to until now, and I fear it will be rather late. On Camas Prairie, from best information I can get, there are about 140 miles of ditches conveying water to farms.

In ordinary seasons these ditches water something like 15,000 acres of good land. A great deal of this has never been broken and the water has only been used heretofore to irrigate the native grass for hay; perhaps it would not water quite so much land thoroughly for grain. I have made some personal examinations of the streams emptying into the valley from the north since you were here, and I am fully satisfied now that the idea of putting reservoirs or dams along the foot-hills to store the water for summer is practicable, and enough water can easily be held to irrigate every acre of land lying north of the Malad, from Baisan Creek to Corral. Beginning at Corral, coming this way, you have in order Three Mile, Soldier, Deer, Elk, and Camp Creeks, all having the very finest kind of natural basins suitable for the enterprise.

It is useless for me to say to you that every foot of this land, on an average 15 miles wide and 30 to 40 miles in length, is of the best of soil and will yield as much as any land in the Territory, with proper irrigation.

But I have always been of the opinion that a system of artesian wells would be most valuable, and less expensive than any other means of irrigation in this valley. This of course depends upon the depth and cost of driving or boring. I am confident that if the Government would put in some test wells it would lead to a general system of private wells sufficient for all purposes.

Say, place one such well on the east end of the prairie, one on the west, and one about the center, showing the cost, practicability, etc., and should this plan prove to be reasonable it would not be two years until almost every farm on the prairie would be watered by them. The people are poor and are not able to make the proper experiments without positive assurance of the feasibility of the enterprise. Numbers would at once attempt it, had they the means. A few of the citizens at Soldier made a trial last summer, and after going near 200 feet in sand and gravel, in which there was an abundance of water, they were forced to abandon the project for the want of funds.

I remain, very truly yours,

HON. JOHN HAILEY,
Spring Creek.

W. Y. PERKINS.

REPORT BY W. C. B. ALLEN.

SHOSHONE, LOGAN COUNTY, IDAHO, August 8, 1889.

DEAR SIR: Pursuant to request of Gov. George L. Shoup I forward briefly some suggestions and facts regarding the necessities and opportunities for irrigation enterprises, storage, reservoirs, etc., in Logan County. By previous arrangement my colleague from this county, by appointment of the governor, Hon. John Hailey, has agreed to report upon the northern half of the county, including Camas Prairie and the section lying adjacent to the Wood River range of mountains. I also transmit herewith the reports of the county surveyor, the county auditor, and the county treasurer upon this subject.

Logan County is formed from the southern half of old Alturas County, and is bounded on the south and east by Snake River. On the south side of Snake River lies Cassia County.

The Snake River Valley and Plains constitute an empire in extent, being from 450 to 500 miles long, and from 50 to 100 miles in width. I think from 10,000,000 to 12,000,000 acres are contained within the drainage area of Snake River and its tributaries.

The area from which the waters and snow fall is derived to produce the volume flowing through the channel of the Snake may be estimated at 40,000,000 to 50,000,000 of acres, or more. Owing to the uniform fall in the valley of the Snake it is probable that by means of storage reservoirs in the upper valley and several dams at convenient points along the river many millions of acres of these arid lands might be made of great value for cultivation and for grazing purposes on both sides of the river. Logan County is nearly in the center of these plains, and is traversed from east to west by the Oregon Short Line Railway, crossing the river at American Falls.

In building this line water had to be hauled by teams from 10 to 20 miles; but on its completion wells were sunk through the lava rock at various points, and the water tanks and stations are supplied by means of wells and pumps. It is demonstrated by this means that a subterranean water supply can be found at depths varying from 100 to 500 feet for a distance of 100 to 200 miles west of American Falls, in what is known as the Lava Beds. At several points there are evidences of water-courses flowing beneath the lava, and in some instances this water comes near the surface. From the abundance of information on this point it is reasonable to infer that artesian wells may become an important feature in reclaiming and supplying the desert with water stations, at least for stock-growing.

A recent project has been started and a company organized for the purpose of constructing a dam at Storey's Ferry, on Snake River, 6 miles south of Minidoka Station, Oregon Short Line Railway. This company—the Snake River Land and Canal Company—propose to divert waters of the river by means of a rock dam and by raising the stream about 35 feet. They can thus reclaim a large body of land on both sides of Snake River, aggregating perhaps 200,000 to 300,000 acres. The line as surveyed in Logan County can be carried as far west as Shoshone Falls. Besides opening up to settlement and cultivation a large area of most fertile fruit and farm lands there are numerous extensive placer mines which such a canal would supply water for, and enable thousands of miners to find profitable employment all the year in working the rich "flour gold" deposits found in the black sand. These gold deposits extend for hundreds of miles along the banks of Snake River, and hundreds of millions of dollars lie hidden in easy reach provided an ample water supply could be obtained.

If the General Government will either construct a comprehensive system of storage reservoirs and canals throughout the Snake River region, or in lieu of this grant to the Territory of Idaho one-half or more of these arid lands, this section has sufficient resources and advantages of climate to become one of the wealthiest and most prosperous valleys in the Union. It is the feeling among the people that Congress should at once make the necessary appropriations to carry on this great work of development, or else transfer the title of these now worthless lands to the Territory or State of Idaho, and not longer prevent the advancement and settlement of the largest and most healthful valley of the Pacific slope.

Yours, truly,

W. C. B. ALLEN.

J. C. STRAUGHAN,
United States Surveyor-General.

REPORT OF THE COUNTY SURVEYOR.

SHOSHONE, IDAHO, August 7, 1889.

DEAR SIR: Complying with your request to furnish information in regard to irrigation in Logan County, I have the honor to report as follows:

Irrigation has been effected on the following-named streams, viz: Big Wood or Malad River and tributaries, Little Wood River and tributaries, Fish Creek, and Clover Creek.

This stream, Big Wood River, which rises in the mountains in Alturas County and is fed by snows, went dry during July of 1888 for a distance of over 100 miles (counting the windings) from its mouth, and has been dry ever since, except during a space of about ten days during the month of June last, when late snows in the mountains caused a freshet. There are about sixty ranches on this part of Wood River (Big). To irrigate these does not make any perceptible difference in the volume of the stream during a freshet. These ranches are now without any water and the crops planted in the spring are dead. The majority of the settlers have taken their families and stock to the mountains. Some have left the country, while a few who still remain on their ranches depend upon the water of stagnant pools along the river, which is all that is to be had for domestic use.

On the north side of Big Wood River, and beginning in T. 3 S., R. 17 E., Bois  Meridian, is a body of good land reaching to Clover Creek, a distance of 36 miles, and having an average width of 8 miles, but little of which is surveyed, and has still settled because of the scarcity of water. In the foot-hills bordering this land on the north are several small streams formed by springs, each of which is almost a river, during two or three months in the early spring of each year, but does not afford sufficient water to flow out of the ca on during the summer months. Here are various reservoir sites, all easy of construction; and at a moderate cost all the lands in this body (over 180,000 acres) could be reclaimed.

Little Wood River, which rises in the Wood River Mountains, though having many springs along its tributaries, is mainly fed by snows. During the past two years the snow-fall in the mountains has been very light, in consequence of which Little Wood River, except during freshets, has only flowed a few miles beyond the ca on through which it emerges from these mountains. At the mouth of this ca on, northeast of Tikura, is a body of good land, about 20,000 acres in extent, a very small part of which is cultivated. The crops here are a total failure this present year and were last year, on account of lack of water.

In the ca on of Little Wood River is a reservoir site, situate in section 14, T. 1 N., R. 20 E., of which I made a preliminary survey a short time ago. Here I find that a dam 600 feet in length will reach across the ca on, the walls of which are 63 feet high on the west side and 103 feet on the east side. A hill approaches near to the ca on on the west side, so that a dam may be raised to the height of 100 feet if wanted.

Within the cañon walls and just below the dam-site lie many hundreds of thousands of cubic yards of basaltic rock, broken from the cañon walls in blocks from 2 to 6 feet square; more than sufficient material to construct a dam of any needed dimensions. Just above this dam-site the cañon opens to a width of half a mile, and holds this width for a distance of 6 miles upstream.

The fall of the river over this same ground is 20 feet to the mile. Hence a dam 100 feet high at this point would impound sufficient water to irrigate 100,000 acres of land. No great natural obstacles are in the way, neither are difficult feats of engineering to be performed in order to conduct the water from this reservoir site onto the lands on the Snake River Desert to the east and south of the town of Shoshone.

On the Snake River Desert south and west of Shoshone is a body of good land of over 200,000 acres. Beginning near Shoshone, and within 4 miles of Little Wood River, is a depression in which is a well-marked water-course which runs the entire length of this land, reaching Snake River at a point near Salmon Falls. Along the line of this water-course and within easy reach of it are a number of lake beds, every one of which could, at moderate expense, be changed into a reservoir, to be filled from Big and Little Wood Rivers when those streams are "flush." Private parties began the construction of a canal over a year ago, intending to use this system of reservoirs, but owing to lack of capital have ceased work.

Silver Creek, a tributary of Little Wood River, flows into the channels of that stream about 20 miles below its present sink just south of Tikura, and is a stream formed entirely by springs which rise in a valley in the northern part of Logan County about 10 miles south of Bellevue. This stream furnishes about 7,000 miner's inches of water, and flows (following the meandering) about 100 miles, does duty for about 6,000 acres of cultivated lands, and but for the bad methods of irrigating in vogue here would do duty for twice as many acres.

Fish Creek and Clover Creek each have large bodies of good land along their course, but neither furnishes sufficient water to irrigate 500 acres during the summer months. Snake River forms the southern boundary of Logan County for a distance of about 200 miles. No irrigation has been effected from this stream as yet, owing to the fact of the expense of conducting the water to the irrigable lands being too great for private enterprise.

Within the cañons of Snake River, which in Logan County extend along the stream for a distance of over 75 miles, there is a body of land containing rich placer mines, ranging in width from one fourth of a mile to 2 miles, part of which is under cultivation and is irrigated from springs, of which there are a great number flowing from out of the wall-rock of the cañon. Many of these springs can be conducted to the lands outside of the cañon by means of flumes of from 2 to 3 miles in length.

The irrigable lands in Logan County are variously estimated at from 1,000,000 to 2,000,000 of acres. I myself believe that the latter estimate is nearer correct than the former. But a tithe of lands in the immediate vicinity of streams is claimed as yet.

On questioning old residents in the mountains I find the annual snow-fall of the mountains estimated at from 20 to 30 feet. Certain it is that most, in fact all, of our now dry streams are impassible rivers during from one to three months in the early spring of each year. This water, which flows to the Columbia and thence to the sea, would if stored in reservoirs for future use enable us to offer homes to some of the many thousands of immigrants, who are constantly passing through Idaho to look for homes in other lands.

I had intended to give you some statistics in regard to the products of Logan County, but have not had time to look up anything of the kind.

In conclusion, will say I have been in Minnesota and Mexico and in all of the States lying between, but in none of those places have I known a climate so equable or a soil so productive of all grain, grasses, vegetables, and fruits as are grown in this temperate region of Idaho.

Respectfully yours,

MILL SANDERSON,
County Surveyor, Logan County, Idaho.

Hon. W. C. B. ALLEN,
Of Idaho Irrigation Committee.

SUMMARY.

Total area of the county	square miles..	5,200
Total area of irrigated land	acres..	50,000
Total area of irrigable land	do	1,250,000

REPORT OF COUNTY TREASURER.

SHOSHONE, IDAHO, *August 7, 1889.*

DEAR SIR: In reply to your inquiry, we have in Logan County nearly 3,500,000 acres of land contained in about one hundred and fifty townships. It has been estimated from reliable sources that fully one-fourth to one-third of this land is capable of producing good crops if irrigated. Some of the best land lies in the southern portion of the county and could all be reclaimed by a canal taken out from Snake River and from storage reservoirs. Of the 1,250,000 acres of good agricultural land in this county there is not to exceed 50,000 acres now under cultivation, the remainder being Government land.

Yours truly,

CHAS. S. DOAN,
Treasurer Logan County.

Mr. W. C. B. ALLEN.

REPORT OF COUNTY RECORDER.

SHOSHONE, LOGAN COUNTY, IDAHO, *August 7, 1889.*

DEAR SIR: In regard to your inquiry as to the number of acres of "irrigable lands" in Logan County, I have the honor to say there are about 3,500,000 acres of land in Logan County, about one-third of which (1,000,000 acres) is unsuceptible of cultivation and would be valuable land if irrigated.

W. B. GEORGE,
Recorder Logan County, Idaho.

W. C. B. ALLEN,
Shoshone, Idaho.

REPORT OF DEPUTY ASSESSOR.

SHOSHONE, LOGAN COUNTY, IDAHO, *August 7, 1889.*

DEAR SIR: Yours of inquiry in regard to the number of acres of tillable land in Logan County, Idaho, at hand. In reply I have the honor to say there are about 3,500,000 acres of land in Logan County, about one-third of which is unsuceptible of irrigation and cultivation.

Respectfully yours,

R. S. TUCKER,
Deputy Assessor Logan County, Idaho.

Mr. W. C. B. ALLEN,
Shoshone, Idaho.

LEMHI COUNTY.

REPORT BY HON. J. W. BIRDSEYE.

SALMON CITY, IDAHO, *July 15, 1889.*

DEAR SIR: Considering your communication referring to irrigable lands in Lemhi County and their extent, I will say that it has been impossible for me to arrive at an absolutely correct estimate, as the time has been too limited for me to visit all sections of the county; but I have made inquiries of intelligent and practical men residing in different locations, and with my own knowledge can arrive at a fair estimate.

First. Irrigation has been effected on the Salmon River, the Lemhi River, and on a number of the smaller streams flowing into the above named rivers, but not to any great extent.

Second. Irrigation is practicable on nearly all the streams in Lemhi County, and to an extent sufficient to cover most of the irrigable area.

Third. Most of the streams furnish a large surplus of water from May until July, after which the supply is not equal to the demand. There are sites on all the streams where large quantities of water can be impounded at a moderate cost.

The length of the Lemhi Valley, through which the Lemhi River flows, is about 70 miles, and the width of the bottom lands from one-half to 2 miles. The extreme width of the valley is from 5 to 12 miles. Above the bottom lands are the bar or table

lands, and still further back, toward the base of the mountains, are hundreds of acres of irrigable lands lying along the different streams.

The bottom lands, to a small extent, have been irrigated throughout the length of the Lemhi Valley, and some irrigation has been effected on the table lands and also on the lands along the stream flowing into the Lemhi and Salmon Rivers.

The land along Salmon River and within Lemhi County is irrigable for a distance of 70 miles; but, owing to the expense of conveying water from the river, but few ditches have been constructed. One tract of land, comprising about 6,000 acres and adjoining the town site of Salmon City, could be covered by a ditch from Salmon River not to exceed 15 miles in length.

The Salmon and Lemhi Rivers furnish a sufficient amount of water without impounding, but it is not practicable to raise the waters of these rivers above the bottom lands without incurring more expense than the ranchmen are able to pay.

The table lands, so far as cultivated, and also the lands lying along the creeks have been dependent entirely upon the streams running from the mountain cañons, and these streams do not furnish a sufficient amount of water for three months each year; but by a system of reservoirs, whereby water can be impounded, it will be practicable to furnish water for a large amount of the irrigable land during the entire season. In my reference to the table lands I mean the first rise above the Lemhi and Salmon Rivers bottom lands, and also higher benches. The first rise is usually an abrupt one of from 50 to 100 feet. With water these benches are very productive; in fact, superior for grain raising to the bottom lands.

On every stream from Carman Creek to Kinney Creek, on the east side of the Lemhi River, is a large amount of good land; but the streams after the middle of July do not furnish one-fourth the water necessary for proper irrigation.

A large ditch, taken from the Lemhi River 30 or 40 miles up the valley and running along through the foot-hills, in connection with impounding the water of the smaller streams, would be a great benefit to this section of the county.

On the headwaters of the Lemhi River there is a large amount of land which, with irrigation, would be very productive; also in the southern portion of the county and in the Pahsimeri Valley are large tracts of very fine land.

I would estimate the amount of land in Lemhi County susceptible of cultivation with irrigation at 500,000 acres. I can not state with accuracy what amount is at present under cultivation, but, from the best information I can gather, the hay crop last season amounted to 8,000 tons, and the grain crop to 100,000 bushels, of which about 40,000 bushels was wheat and 60,000 oats; the value of hay from \$6 to \$10 per ton, wheat \$1 per bushel, and oats from 1 cent to 1½ per pound.

Wheat will yield from 30 to 50 bushels per acre; oats, from 40 to 70 bushels. Vegetables of nearly all kinds can be raised in abundance, and fruit trees are doing well.

Our water sources are the Rocky Mountains and Salmon River Range for the small streams. The Salmon River heads in the Saw Tooth Range about 150 miles south of Salmon City, and the Lemhi River heads in a spur of the Rocky Mountains known as the Birch Creek Range, about 75 miles southeast.

The amount of water flowing in the mountain streams varies from 100 to 300 inches at low water to as many thousand during high water.

We do not depend upon rain, but upon the melting snow in the mountains. No dependence can be placed upon the rain-fall for agricultural purposes, but for grasses growing upon all the ranges rain is the only reliance. The land in Lemhi County lies particularly well for the distribution of water, and nearly all the lands fit for agricultural purposes can be reached.

Respectfully submitted.

J. W. BIRDSEYE.

JOSEPH C. STRAUGHAN,
United States Surveyor-General.

SUMMARY OF LEMHI COUNTY REPORTS.

This county has about two hundred and fifty ditches used for agricultural purposes, each from one-half mile to 6 miles long; for mining purposes, about one hundred ditches, with a total length of about 200 miles.

Products for 1888.—Hay crop, 8,000 tons, worth \$6 to \$10; wheat, 40,000 bushels, worth \$1; oats, 60,000 bushels, worth 35 to 50 cents. Fruits and vegetables of all the hardy varieties abundant.

Yield per acre.—Alfalfa clover, 4 to 5 tons (2 crops); red clover, 3 to 4 tons; timothy, 2 to 3 tons; wheat, 30 to 50 bushels; oats, 40 to 70 bushels.

Snow-fall usually 6 to 8 feet (last year very light). "Duty of water," 1 miner's inch per acre. Irrigation season, May 15 to August 15.

Area now irrigated, 9,715 acres. Area of good irrigable land, 500,000 acres. Area of the county, 4,300 square miles.

NEZ PERCE COUNTY.

REPORTS BY C. P. COBURN AND W. P. BELL.

LEWISTON, IDAHO, July 20, 1889.

SIR: In response to your circular letter of June 8 instant, I have given the subject of irrigation considerable attention.

The Snake and Clearwater Rivers lie too low to be available for irrigation in this immediate vicinity. When the Nez Perce Reservation is opened it may be practicable to bring water from either of these streams for irrigation purposes. But, owing to the little fall of the streams and the steepness of the banks on each of these rivers, it requires too long ditches; consequently too great an expense to be practicable at present.

There is now a ditch taken from Clearwater River about $4\frac{1}{2}$ miles in length, covering the Clearwater bottom, comprising about four sections of lands, and the water thus brought is used for irrigation and milling purposes.

In company with W. P. Bell, county surveyor, we have made a preliminary survey of a ditch from the South Fork of Sweetwater Creek to the table lands southeast of Lewiston, and find it in every way practicable, and water can be brought on the plateau, covering a large body of excellent land, at a small expense compared to the benefit that would be derived therefrom, and this it would benefit fully \$100,000 and it could be completed at an outlay not to exceed \$9,000.

In this connection I will say that the reason this has not been undertaken as a private enterprise long since is on account of objections raised by former Indian agents of the Nez Perce Reservation, to wit: That this stream, although having its source upon unoccupied Government land, it flowed on to the reservation and might in the future be required for irrigation or milling purposes. But we find that none of the water of the stream is used for irrigation, and that the other branches furnish all the water required, and in fact far more than is used for either irrigation or milling purposes. We therefore earnestly recommend that an appropriation be made for this purpose.

There is also a large tract of valuable land, comprising 15,000 or 20,000 acres, southeast of Lewiston susceptible of irrigation by artesian wells, and could the fact be once demonstrated that it is feasible, and flowing water be obtained, it would increase the value of this large tract a hundred-fold.

From a careful examination of all the surroundings we deem it in every way feasible, and have no doubt flowing water can be obtained by artesian wells. We therefore earnestly recommend that an appropriation be made by Congress to test the matter fully.

Respectfully yours,

Governor GEORGE L. SHOUP,
Boise City, Idaho.

C. P. COBURN,
W. P. BELL,
County Surveyors.

REPORTS BY FRANCIS F. PATTERSON AND CHARLES M. FORCE.

LEWISTON, IDAHO, June 26, 1889.

DEAR SIR: In reply to your circular letter of the 14th instant we have to say that our information on the subject of irrigated and irrigable lands is very meager, but are glad to furnish you with what little information we have.

In reply to your first question we would state that there is practically no irrigation in this part of the Territory. It is not necessary, in the first place, and in the second place it is hardly practicable. There are some tracts of land which would be improved by irrigation, but by far the larger part of the agricultural land in this section does not need irrigation to raise large crops of grain, vegetables, and, in many places, fine fruit.

The agricultural land of northern Idaho lays principally on the high table lands, which are cut by more or less deep cañons in which run the rivers. There are a few of the smaller streams that flow through more or less wide and fertile valleys which could be irrigated, but do not need irrigation in the least, while the land which needs irrigation most is so far above the water-courses that irrigation is not practicable. There is, in fact, almost no land at all which might be called agricultural land where irrigation is absolutely necessary to raise crops, and it was long ago decided that the "desert land act" did not apply to this land district.

Very respectfully,

J. C. STRAUGHAN,
United States Surveyor-General of Idaho.

FRANCIS F. PATTERSON,
Register.
CHARLES M. FORCE,
Receiver.

ONEIDA COUNTY.

REPORT BY D. W. STANDROD AND H. R. EVANS.

MALAD CITY, IDAHO, August 8, 1889.

DEAR SIR: Your circular letter of the 14th of June last, together with the letter of Governor Shoup appointing us as the authorized officers for this (Oneida) county to prepare a report on the facilities afforded in this county for increased irrigation, together with statistics of amount of water supply in the county and the acreage of lands under irrigation, was duly received and considered. A careful report of the matters was prepared by us and mailed to you on the 31st day of July, but we have since been informed that said report has not been received at your office, we therefore respectfully submit the following:

NAMES OF STREAMS ON WHICH IRRIGATION HAS BEEN EFFECTED AND TO WHAT EXTENT.

Big Malad Creek.—Extent of land irrigated by it, 1 mile in width by 5 miles in length. This stream rises in a large spring situated down in the valley, and its water supply rarely, if ever, varies with the season. About 1 mile below its source is a large gulch or basin, through which it flows, that affords a most practicable and inexpensive site for a storage reservoir, which can be constructed by building a dam of earth taken from the sides of the gulch, and which is capable of storing sufficient water to irrigate thus three times as much land as is now irrigated by it. Several sections of land lie around this stream that are wholly unutilized, covered with sage brush and absolutely valueless as it is, but comprising the richest and most productive soil in Malad Valley—a soil that has been tested and, when brought under the advantages of irrigation, been proved to be the most productive of fruits, grain, and vegetables.

Mill Creek, Birch Creek, Devil Creek, and Marsh Creek, all running into one ditch.—Extent of land irrigated by them, three-quarters of a mile wide by 10 miles long. On each of these streams are most excellent sites for reservoirs, which can be built at a comparatively small cost, and we are safe in saying the water supply could be trebled, the irrigable lands being fully sufficient also to utilize all of it.

Little Malad Creek.—Extent of land irrigated by it 1 mile wide by 4 miles long. This stream rises in the mountains high above Malad Valley and flows for a long distance. The water supply from it is greater than that from any other small stream in the valley, it ordinarily being a strong stream and furnishing a large volume of water for several miles above Malad Valley proper. This stream runs down a small valley ending at its lower end by a "narrows" which affords a most delightful site for a reservoir. Such reservoir could be built by means of an earthen dam of 175 feet long and 30 feet high, and could be erected at a cost of \$2,000, which will fill a basin of water to the height of 20 feet and cover an area of 160 acres with 10 feet of water. It is difficult to say how much land could be irrigated with the water so stored, but the water supply of said stream would be increased at least fourfold. Lying below said reservoir is a large tract of rich black sandy loam, covered by immense forests of sage brush and left in its desert condition.

Deep Creek.—Extent of land irrigated by it one-half mile wide by 3 miles long. We desire to call especial attention to the facilities for increase in the water supply of this stream. It furnishes the water supply for Malad City, containing a population of 2,000 persons, and in the early spring is used for irrigating hay lands situated below said town. It is one of the most useful streams in the valley, and does not furnish one-fourth of the water absolutely necessary for the wants of citizens which it was intended to supply.

About 8 miles north of Malad City, and where the headwaters of said stream flow from the mountains, is a site for a reservoir which can not fail to attract attention when observed as the most natural site for a storage basin that could have been prepared by the hand of nature; a small valley covered with sod, impenetrable by water, and furnishing a most excellent bottom for a basin of this kind; a natural place for constructing a dam of earth and forming a basin 1 mile or more in length by an average of 80 rods in width, with comparatively little pressure on the dam and having a safe outlet. No investment could be made that would derive better profits and afford relief to a community than the construction of this reservoir. Many places along said stream above Malad City furnish excellent sites for smaller reservoirs, which could be constructed at small expense, whereby the water might be increased immensely.

Two Mile Creek.—Amount of land irrigated by this stream is one-half mile wide by one-half mile long. This stream lies above a district of most excellent hay lands, which are several school sections. It runs through an immense gorge with high cliffs on either side, and reservoirs could be constructed on it in many places at compara-

tively little cost, the great walls of the mountains on either side furnishing ample material for the construction of said dams. Especially would these reservoirs be practicable and a great saving store, on account of the flow of water from the snow on the high mountains above.

Cherry Creek and Henderson Creek.—Amount of land irrigated by them, half a mile long and half a mile wide. These creeks lie above a firm section of natural hay-producing country; and while the water supply afforded by them is quite limited, yet the high mountains from which they flow furnish immense streams in the early spring during the melting season. This water, of course, is lost and goes off too early to furnish any substantial irrigation. Splendid sites for reservoirs are situated on these streams and could be easily built, whereby the water could be increased many fold.

We desire to say further that Malad Valley comprises, as we believe, the richest soil and the most productive region of Idaho. It is one of the oldest settled valleys in the Territory, the population composed of thrifty farmers, and yields in grain the finest quality and largest quantity per acre of any lands we are acquainted with in the Territory.

The one great drawback to its prosperity and increase of population is the scarcity of water supply. The lucerne yield itself will enrich the farmer and has been a mighty factor in the encouragement of stock growing. Where the water supply is furnished farmers never fail to produce three crops of this hay per season, yielding from 6 to 8 tons per acre. We do not believe there are more than one-fourth of the lands of said valley under cultivation, the cause of which is wholly due to the insufficiency of the water supply. It is in extent about 10 miles wide by 20 miles long.

Weston Creek.—Extent of land cultivated by it 1 mile wide and 6 miles long. This is a strong stream, running a distance of 5 miles through a cañon, passing out at Weston Valley. Many excellent sites for reservoirs can be found along the valley from which it flows. A few years ago a reservoir was constructed on this that has been successfully managed since, and clearly demonstrates the great saving of water that can be had in this way. The reservoir is situated about 3 miles up the cañon above the valley and is built by constructing a dam of earth across the valley. We are informed that this reservoir cost about \$2,000 and is situated near the southeast corner of T. 15 S., R. 37 E. The dam is about 15 feet in height by about 300 feet long. It is claimed by the farmers, who take water from this reservoir, that the water saved in the reservoir irrigates three times as much land as was irrigated by the stream prior to constructing the reservoir. An extensive area of land lies below this reservoir susceptible of irrigation that remains in its desert state and public land of the United States.

Five Mile Creek.—Extent of land irrigated by it 1 mile wide by 6 miles in length. This stream is small but could be trebled by constructing a reservoir in a cañon through which it flows. Sufficient land lies below it, that is now desert, on which all the water so increased could be used.

Clifton Creek, in the same neighborhood, is similar in all respects to Five Mile Creek.

Cub River.—Extent of area irrigated 1 mile wide by 6 miles long. We append herewith a map showing the position of Cub River and Mink Creek, and points on same where reservoirs can be constructed, and estimated cost of same. The country that this water would irrigate is very rich, and is a fine fruit-growing section. A large area of land lies under it that is now desert and only lacks irrigating facilities to make it blossom like the rose.

Warm Creek.—Extent of land irrigated by it 1 mile wide and 5 miles long. We append herewith an article prepared by the Hon. Frank Campbell, a man in vast experience in irrigation, he having been a former citizen of Nevada. We submit it as a report covering the Rock Creek, Warm Creek, and American Falls country, and I vouch for its correctness.

In conclusion we desire to call attention to a vast section of country lying on the west side of Bear River in this county, comprising T. 15 and 16 S., R. 35 E. While these lands do not differ in richness and productiveness from that we have herein described, it is the most thoroughly arid and desert country in the county, having no springs or small streams arising upon or flowing through it. Bear River could easily be conducted by means of a canal to and upon these lands.

From present indications capitalists in the East are endeavoring to divert all the waters of Bear River at a point called the "Narrows," about 20 miles below the lands above referred to, and use the same for irrigating lands in Utah and supplying Ogden City with water. One-third of this stream would fully irrigate the lands in this county above referred to, and we deprecate the fact that unless the water is soon diverted for the lands above referred to it will all be appropriated for Utah Territory, thereby depriving us of what would seem naturally due to us,

The expense of taking this water from Bear River for the lands in Idaho is comparatively light, when considered with the vast expenditure that will be acquired to apply it to the uses in Utah above referred to.

Respectfully submitted.

D. W. STANDROD.
H. R. EVANS.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

REPORT BY FRANK CAMPBELL.

The northern portion of Oneida County includes two considerable bodies of land that possess a surface capable of being irrigated, the "Snake River Plains" and "Rock Creek Valley." The first extends west from the Portneuf River 20 miles, and skirting Snake River on the south, with an average width of 2 miles. The largest and best half of this land, together with all the waters of Portneuf River and Bannack Creek, is embraced by the Fort Hall Indian Reservation. Situate between this strip of arid bench land and Snake River there are about 4,000 acres of river bottom land that produce wild hay by the overflow of the river, the yield of which could be greatly increased by irrigation.

Warm Creek, containing about 200 inches (miner's), is the only stream outside of Fort Hall Indian Reservation that can be used upon this strip of sage-brush land until the waters of Snake River are diverted by a canal commencing near Eagle Rock, about 60 miles distant.

At Warm Creek about 2,000 acres of land have been settled upon and the natural flow of the stream fully utilized. The result is about 400 acres in grain, vegetables, and alfalfa. This stream is supplied by a never-failing spring (or springs). The freshets resulting from melted snows are small and variable, some years amounting to nothing.

A reservoir site exists, sufficiently high on the stream to cover a vast number of acres. A dam 100 yards long and 12 feet high, average width about 12 yards, aggregating about 15,000 yards of earth, could be built at a cost of 10 cents per yard, amounting to \$1,500, that would impound 40 acres of water, with an average depth of 20 feet, which, it is safe to estimate, would irrigate 1,500 acres additional land. The reservoir site is private property and would cost about \$2,000.

Bear Creek Valley is about 20 miles long, and settled the entire distance. About 7,000 acres are in the hands of private parties. The stream furnishes 1,000 miner's inches for irrigating purposes, and is fully utilized, resulting in the cultivation of 2,000 acres in grain, vegetables, and alfalfa.

There are several thousand acres of Government land that can not be cultivated for lack of water. I am not prepared to report upon any natural reservoir sites in this valley, but understand there are three or four small ones, containing from 10 to 40 acres each.

Snake River contains an inexhaustible supply of water that must be made to do duty in rendering the barren plains beautiful and habitable for man.

The feasibility of using it has been demonstrated by private enterprise. The duty of the United States Government in the premises is to demonstrate practicable routes for canals for conveying water out upon these plains; also survey and report the number of acres along the route suitable for irrigation, with such data as a basis upon which private capital would quickly avail itself of the rich rewards that would surely follow. The distribution of this immense body of water upon the plains of Idaho is a gigantic enterprise that will give full employment to the skill and energy of our citizens for the next generation.

Respectfully submitted.

FRANK CAMPBELL.

Summary of Oneida County report.

[Compiled from reports of D. W. Standrod, H. R. Evans, and Frank Campbell.]

Localities.	Lands.		Remarks.
	Irrigated.	Irrigable.	
Big Malad Creek.....	<i>Acres.</i> 3,200	<i>Acres.</i> 9,000	Flows from a large, permanent spring, and has a site for reservoir capable of supplying 9,000 acres more good land.
Mill Creek.....	4,000	12,000	{ Connected by one ditch. Very good location on each creek for reservoirs.
Devil Creek.....			
Birch Creek.....			
Marsh Creek.....			
Little Malad Creek.....	2,640	10,000	Has a great amount of water. Site for reservoir very good. A dam 30 feet high, 175 feet long, costing \$2,000, will cover 160 acres 10 feet deep, or 63,000,000 cubic feet of water.
Deep Creek.....	1,600	5,000	Supplies Malad City (population, 2,000) and lands around it. Eight miles above the city a very good site for a dam that would cover 160 acres 15 feet deep at small expense.
Two-Mile Creek.....	180	5,000	Site for reservoir very good.
Cherry Creek.....	180	5,000	Site for reservoir very good. Both of these streams would cover much high land that is very productive in hay—6 to 8 tons per acre annually.
	11,160	46,000	
The above streams are all in the so-called Malad Valley. There are smaller streams and large tracts of good land not herein reported upon. As a whole Malad Valley has a body of good irrigable land (with sufficient water storage), that is, 20 miles long and averaging 10 miles wide, or 128,000 acres.			
Weston Creek.....	4,000	.....	Has a reservoir 300 feet long, 15 feet high—cost \$2,000—and it increases farming area from 1,200 acres to 4,000 acres.
Five-Mile Creek.....	4,000	12,000	{ Small streams; capable by means of reservoirs of irrigating three times as much.
Clifton Creek.....	4,000	12,000	
Cub River.....	4,000	10,000	
Mink Creek.....	4,000	12,000	
Warm Creek.....	3,200	12,000	
Snake River.....	4,000	.....	A small strip on south side of river; overflowed. Main supply is from a spring. Can not be improved by reservoirs, as the floods are uncertain. Some 20,000 acres might be irrigated by a canal from Eagle Rock.
Warm Creek, a tributary of Snake River	400	4,000	
	27,600	62,000	
Total.....	38,760	108,000	

GENERAL DESCRIPTION.

Total area of Oneida County 2,600 square miles, exclusive of the reservation.

In general, this county is now irrigated in so far as it can be without resort to storage reservoirs on its small tributary streams, and the construction of a canal from a point on Bear River, in Bingham County.

Both methods seem to be advisable. In some localities, reservoirs will be cheapest, and on some large tracts, notably T. 14 and 15 S., R. 38 E., a canal from Bear River is the only available method.

These lands are so excellent that it is the interest of that populous neighborhood and of the Territory of Idaho that they should be reclaimed, and thus help to bear the burdens of the State.

In the report of Messrs. D. W. Standrod and H. R. Evans they say that an eastern syndicate are about to monopolize all Bear River and conduct it into Utah, against which they strongly protest.

OWYHEE COUNTY.

REPORT BY FRANKLIN W. HULETT.

SILVER CITY, July 8, 1889.

SIR: In reply to your circular letter of June 8, 1889, I herewith submit the following:

Streams where irrigation has been effected.	Extent of lands.		Ditches.	
	Irrigated.	Irrigable.	No.	Length.
	Acres.	Acres.		Miles.
Jump Creek.....	75	8,000	1	$\frac{1}{2}$
Squaw Creek.....	200	12,000	1	1
Reynolds Creek.....	600	15,000	9	17
Sinker Creek.....	500	.....	4	5
Castle Creek and tributaries.....	1,100	17,000	18	19
Shoo-Fly Creek.....	300	10,000	3	3
Dry Creek.....	300	20,000	4	5
Bruneau River, Bruneau Valley, and adjacent land west*.....	1,500	100,000	7	23
Big Flat or Upper Bruneau River*.....	800	50,000	(†)	
	5,275	230,000	47	73 $\frac{1}{2}$

NOTE.—Length of time each year—average three months. There is sufficient water to irrigate its irrigable lands.

* By Snake River Canal.

† Not known.

During the months of February, March, and April of each year, average, there is sufficient water in all the streams mentioned to irrigate all the lands of value just at the time when irrigation is not necessary. Usually irrigation is commenced about the middle of May, and is continued (if there is sufficient water) until about the 1st of October. There are large tracts of fine land lying westerly from Bruneau Valley, extending as far as Birch Creek. There is a practicable route for a canal, beginning at a point near the south boundary of T. 7 S., R. 6 E., on Bruneau River; thence in a westerly direction to the last-mentioned creek.

Respectfully,

FRANKLIN W. HULETT,
United States Deputy Mineral Surveyor.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

REPORT FROM S. J. PRITCHARD.

Robertson's Fork of Bruneau.—Extent of irrigation, 7 by 1 miles; practicable, 10 miles square; furnishes sufficient water about three months yearly; has five ditches, average 1 mile; good site for reservoir.

Three Creek.—Extent irrigated, 3 by three-fourths miles; practicable, 6 by three-fourths miles; furnishes sufficient water about three months yearly; good site for reservoir; has three ditches $1\frac{1}{4}$ miles long.

Bruneau River.—Extent irrigated, 12 by $1\frac{1}{4}$ miles; ten ditches from 1 to 8 miles long; furnishes water about six months. There is an excellent site for storage of water, and the water from this stream can be made to cover thirty sections of good agricultural land.

Shoo-Fly Creek.—Extent of irrigation, 3 by 1 miles; practicable, 8 by 1 miles; three ditches from 1 to 3 miles; furnishes sufficient water about two months yearly; excellent site for reservoir.

Birch Creek.—Practicable for 9 miles long and from one-half to 2 miles wide; excellent site for storage of water; sufficient water for about two months yearly, with a small stream the greater part of the year.

Castle Creek.—Irrigated for 8 by one-half miles; practicable fifteen sections; furnishes water until about 1st of May; thirteen ditches; one-half to 3 miles long; excellent site for reservoir.

Catherine Creek.—Irrigated for 7 by three-fourths mile; ten ditches, 1 to 2 miles. Excellent sites for reservoir.

Pickett Creek.—Irrigated 4 by one-half mile; seven ditches, from 1 to 2 miles. Excellent site for reservoir. These last two streams join, and with water stored could be made to cover about fifteen sections of good fertile land.

Sinker Creek.—Six miles by one-half miles.

Reynold's Creek.—Irrigated, 12 miles long, land one-half mile wide. Practicable about fifteen sections. Excellent storage site. Furnishes sufficient water about two months yearly.

Cow Creek.—Irrigated 3 by one-half mile.

Jordan Creek.—Irrigated 8 by 1 miles. Sufficient water the entire year.

There has been some land located and irrigated, and water-rights located upon and water diverted from all the following streams: Dead Wood, Brown's, Squaw, Jump, Trout, Williams, South Mountain, Boulder, Lone Tree, and Cherry Creeks.

In nearly all these streams in this county there is a great body of water for several months in the spring, so that where reservoirs could be constructed there would be sufficient waste water during these periods of high water to fill the various reservoirs.

There are about one hundred irrigation ditches, averaging about 2 miles long. There are about 12 ditches used for mills and mining averaging about 3½ miles long.

These streams generally have their sources in the mountains, and are fed by springs (usually formed from the rains and melted snows incident to mountains), and from the melted snow and rains.

At least one half of the settlers of Owyhee County are settled upon unsurveyed lands.

The average value of crops per acre is about \$40. If Snake River were diverted, it could be made to cover 60 square miles of good agricultural land in one body in Owyhee County.

Respectfully submitted.

S. J. PRITCHARD.

SUMMARY OF OWYHEE COUNTY REPORTS.

Localities.	Lands.		Ditches.		Remarks.
	Irrigated.	Irrigable.	No.	Length.	
	<i>Acres.</i>	<i>Acres.</i>		<i>Miles.</i>	
Bruneau River (and land west.	1,500	100,000	10	45	Has water for six months; very good site for reservoirs.
Robertson's Fork of Bruneau.	4,500	6,500	5	5	Has water for three months; very good site for reservoirs.
Three Creek	1,500	3,000	3	5	Do.
Shoo-Fly Creek	200	10,000	3	6	Has water for two months; very good site for reservoirs.
Dry Creek	300	20,000	1	2	
Birch Creek		7,200			Has water for two months; very good site for reservoirs.
Castle Creek	1,500	19,600	13	25	Do.
Catherine Creek	8,200	9,600	10	15	Has water for three months; very good site for reservoirs.
Pickett Creek	1,200		7	10	Has water for two months; much-needed reservoir.
Jump Creek	75	8,000			
Sinker Creek	500				
Squaw Creek	200	12,000	1	1	
Reynolds' Creek	900	12,600			Has water for two months; very good site for reservoirs.
Cow Creek	1,000				
Indian Creek	5,000				Has water for twelve months.
Mining and Milling ditches.			12	42	Has water for four months.
Snake River		40,000			In one body. Can only be supplied by a long canal from Snake River.
	21,275	248,500	66	153	

RECAPITULATION.

Acres irrigated	21,275
Acres irrigable	248,500
Number of ditches	66
Miles of canals and ditches	153
Average season	months.. 32
Total area	square miles.. 7,912

KOOTENAI COUNTY.

REPORT BY GEORGE A. MANNING.

SIR: In reply to the questions in your circular of June 15, in regard to irrigation in Kootenai County, I would in answer say first: That owing to the formation of the country, it being generally mountainous, it is not possible to irrigate any considerable amount of land in the county, and would further state I do not know of any land in the county being irrigated at the present time, and further it is not considered necessary to irrigate in order to raise fair crops of cereals, vegetables, or fruits. There are three considerable rivers running through parts of Kootenai County.

The most northerly, the Kootenai River, runs through the northeast corner of the county, the country being mountainous, with some very fine bottoms along the river which mostly overflow during the spring and early summer, caused by the melting snows in the mountains. After the water recedes from these bottoms grasses of good quality quickly spring up, and the cut of hay from them will average 2 or 3 tons to the acre; on the higher parts of the bottoms fine vegetables grow. About the middle of September last year I saw corn, potatoes, squash, pumpkins, and tomatoes thoroughly matured and ripened on the ranch of Mr. Long, about 2 miles above Bonner's Ferry.

The Pend d'Oreille River, after leaving the lake of the same name, runs about 25 miles through Idaho. The character of the country is about the same as Kootenai River, with much the same kinds of bottom-lands.

The Spokane River runs through the county a distance of about 13 miles, from the foot of Coeur d'Alene Lake to the Washington line. The lake and river being so much lower than the surrounding lands, it would be impossible to take the water out for irrigating purposes, and the only lands that could be benefited by irrigation is thus deprived of it.

The land that I refer to extends from the Washington line east for about 12 miles and a distance of about 25 miles north from the Spokane River; is mostly open prairie, with occasional small groves of pine. The soil is gravelly loam, and it produces fair crops of grain and vegetables. It stands the drought well, but is absolutely without water, with the exception of two lakes, as marked on the plat (Hayden Lake and Fish Lake). Hayden Lake is much below the surface of the prairie, consequently irrigation from that source is practically impossible. There is no outlet to the lake and no streams of any consequence running into it. Its principal supply is from the melting snow on the surrounding mountains.

Fish Lake is a body of water about 5 miles long, with an average width of about 1 mile, during the spring rains and melting of the snows in the spring. A small stream issues from it, but it runs along the base of the hills on much lower ground than the surrounding prairie and sinks in the gravelly soil after running a few miles. The prairie is nearly all claimed and fast being brought under cultivation. The great drawback is the want of water for domestic purposes, farmers having to haul their water from 1 to 6 miles. Three wells have already been sunk, one on the ranch of E. R. Childs near Post Falls, about 2 miles north of Spokane River. He found water at a depth of about 172 feet, which he proposes to raise by a windmill. About 4 miles north of Mr. Childs's place Mr. Eisch found water at a depth of 225 feet. He has a windmill in successful operation, but the amount of water raised is small; still he has enough for domestic uses. About 4 miles northeast of the last well Mr. Henry Reiniger sank 311 feet, finding a supply of water at that depth, which he proposes to raise by windmill.

With a supply of water for domestic purposes and for watering stock the prairie referred to above can be successfully cultivated, which would add materially to the wealth of the county and Territory. It is generally thought that artesian wells could be bored on the prairie that would furnish an abundant supply of water, but as the cost would be considerable, no one feels able to take the risk of a failure; but could the fact be demonstrated by sinking a well the farmers could club together and sink others, thereby securing an ample supply for all their wants.

I am, very respectfully, yours,

GEO. A. MANNING.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

REPORT BY WM. ASHLEY, JR., COUNTY SURVEYOR.

KOOTENAI, IDAHO, *July 15, 1889.*

DEAR SIR: Your favor of 22d ultimo and map received, but was sent to Murray and I did not get it until the 27th, as my post-office is Kootenai.

There is very little irrigating done in Kootenai County. In the northern part there is abundance of water to irrigate all irrigable lands, but in the southern portion water is scarce and the land is very gravelly, so that it is hard to dig ditches.

I would suggest that artesian wells will be more practicable than irrigation ditches or canals.

The Kootenai River, Pack River, Clark's Fork, and the Pend d'Oreille Rivers afford abundance of water for all the land irrigable, but the bottom-lands generally overflow during high water.

Yours, very respectfully,

WM. ASHLEY, JR.,
County Surveyor.

JOSEPH C. STRAUGHAN,
Surveyor-General.

WASHINGTON COUNTY.

REPORT BY THOMAS C. GALLOWAY.

WEISER, IDAHO, *July 2, 1889.*

SIR: Water has been appropriated in two hundred and seventy ditches, from the Weiser River and its twenty-five tributaries.

Most of the ditches are small and short, and are only intended for private use along the alluvial bottom-lands.

The Pence ditch, from the Payette River, intended to cover about 10,000 acres of rich, level sage-brush land on Snake River, above the mouth of the Weiser, is 12 miles long.

The Mill ditch, on the north side of the Weiser, is 5 miles long, and has a capacity of about 1,000 inches. The Weiser canal is 17 miles long, and is intended to irrigate 16,000 acres on the north side of the Weiser River and on Snake River below Weiser City.

Owing to four successive dry years, and no means of storing and holding back from the very abundant spring supply, many of the smaller ditches are dry, and the larger ones have not sufficient head to maintain a full and uniform flow, which is necessary.

With but comparatively little expense water could be stored on any of the small streams in great abundance, or dams could be easily, cheaply, and safely built in the narrow cañons between the different valleys on the main Weiser. Water stored anywhere above would benefit all below.

The price charged, where water is sold, is \$1 per miner's inch, a very indefinite quantity, but expected to be enough to irrigate 1 acre. The irrigable land in Washington County is about 500,000 acres. The water-shed is in the shape of a horseshoe, 30 miles across and 100 miles in length.

Land, where the supply of water is certain, is worth from \$15 to \$20 per acre; land without water is worthless.

Unless means are devised for holding back and a better way established for distributing and using water in this county, the larger and longer ditches will be abandoned, while the smaller ones will become sources of local strife and litigation.

Very respectfully, yours,

THOS. C. GALLOWAY.

JOSEPH C. STRAUGHAN,
United States Surveyor-General for Idaho.

WEISER, *August 11, 1889.*

DEAR SIR: Yours of the 5th instant, with map inclosed, at hand to-day. It is impossible to designate the numerous ditches on the map in this county.

I have marked one Pence ditch from Payette River, which I consider very important, as the large body of land, at least 10,000 acres, is No. 1, and without water.

No. 2, Mill ditch. No. 3, Weiser canal. No. 4, Middle Valley.

There are fourteen ditches on Manns Creek, now all dry. No water in Pence ditch. The Weiser canal takes all the water in the river and only affords at this time a small quantity, probably enough to water stock, orchards, and gardens.

The water is lower now than for twenty-six years to my knowledge. The question of prior and riparian rights has not been adjudicated; and as the upper valleys do not use water, only when it is short, this works a great hardship here and will do so until some means is devised for storing the spring supply—which always has been abundant.

Respectfully,

JOSEPH C. STRAUGHAN.

THOS. C. GALLOWAY.

NOTES ON WASHINGTON COUNTY.

The irrigable lands in Washington County lie in a horseshoe form, about 100 miles long on its outer line and 30 miles across the chord of its inner segment, embracing an area estimated at 500,000 acres. Less than one-tenth of this is yet irrigated, and this one-tenth but poorly supplied with water. The improved lands here that have water are worth \$20 per acre.

The mountains that supply this valley are not high nor extensive; their snows melt away in the early spring, the flood water is soon gone, and the dry season begins early, and the inhabitants of the lower valley find that the settlers above can absorb all the water at this season when it is of much use.

Sites for storage reservoirs are reported as existing in almost every lateral tributary, and to these sites I respectfully call attention in order that this valley may obtain the earliest attention and relief.

This county is bounded on the east by a low range of mountains, and on the west by Snake River, which is in a deep valley, too low to be brought out for irrigation.

The Weiser River with its twenty-five tributaries are all within this county, and the county embraces the whole of the Weiser drainage and no more. It is therefore a separate district for irrigation and the storage system is unquestionably the only proper plan, and it is in this locality a great and pressing want.

REPORT OF BORINGS FOR LOCOMOTIVE SUPPLY WELLS ON OREGON SHORT-LINE RAILROAD, IDAHO.

POCATELLO, August 8, 1889.

DEAR SIR: Yours of yesterday duly to hand, and with return mail send you herewith depth of our wells west of Pocatello. I name them in their order proceeding westward:

Wapi well, 250 feet deep—through lava and in sand.

Minidoka well, 335 feet deep; Kimama well, 335 feet deep; Owinza well, 483 feet deep; Bliss well, 450 feet deep; Bisuka well, 390 feet deep; Mora well, 380 feet deep; Nampa well, 154 feet deep. Not through total thickness of lava.

This, I am afraid, is but meager information, but it is all I have on hand. The wells were put down a long time ago and all records of section of strata, if any were kept, are in Omaha.

Hoping this may be of some service to you, I am, very respectfully, yours,

V. C. ROEDER,
Division Engineer.

JOSEPH C. STRAUGHAN, Esq.,
Surveyor-General of Idaho.

STATEMENT OF V. C. ROEDER, ENGINEER IN CHARGE OF IDAHO DIVISION UNION PACIFIC RAILWAY, POCATELLO, IDAHO.

By a glance at a map of this part of the Territories, it will be noticed that the Oregon Short Line Railway is located for more than half its distance along streams of considerable size which never run dry during the summer months, such as Hamsfork, Bear, Portneuf, and Snake Rivers. At stations on those portions of the railroad the question of a supply of water is easily answered by springs in the adjoining hills, permitting of a gravity supply, or by pumping from wells 10 to 30 feet deep, or directly from the streams.

From American Falls to Caldwell, however, a distance of 22½ miles, the railroad runs through an arid country of lava, which in general is covered by a deep, rich soil, and now yields, owing to the absence of water, only sage brush, but which, with a supply of water, with our mild and equable winters, would yield fruits and grain in abundance. On this desert the railroad company were compelled to sink, at regular intervals, deep wells 8 inches in diameter, and varying in depth from 150 to 4½ feet. These wells are not, strictly speaking, "Artesian" as the water does not rise or overflow in the same, but must be brought to the surface by deep well pumping machinery.

Characteristic features of the Snake River Valley are the rifts and crevasses in the lava rock, which vary from an inch to several feet in width and extend to a depth of several hundred feet below the surface. It is into these crevasses that the waters of the northern portion of the Snake River Valley sink, and in all probability it is this water that is tapped by the deep wells referred to.

Should these wells be carried deeper and below the lava overflow subterraneous water would no doubt be reached and flowing wells obtained.

Of these deep wells there are nine on the Oregon Short Line Railway, in the region referred to, and located at the following stations:

Feet deep.		Feet deep.		Feet deep.	
Wapi.....	340	Owinza	400	Bisnka	390
Minidoka.....	425	Bliss.....	483	Mora.....	380
Kimama.....	325	Clift	450	Nampa	150

In regard to the cost of these wells I can obtain no data here, nor do I think that their cost, being driven six years ago or more, could be used as a fair basis for an estimate of similar work to be done now or in the future.

There is no storage system in use on this division. The surface supply is good, except in the district above mentioned, but owing to the nature of the lava which overlies the greater portion of Idaho, the banks of the streams are nearly always vertical and quite high, so that dams and reservoirs would have to be resorted to to bring the water on the adjoining lands. The great number of large springs would seem to indicate an abundant subterranean water supply. There are no large irrigating enterprises on lands near the railroad line. There are only small private ditches irrigating lands immediately adjoining the rivers.

STATEMENT OF JOSEPH C. STRAUGHAN RESUMED.

The CHAIRMAN. You have here the reports from the various counties?

Mr. STRAUGHAN. Yes.

The CHAIRMAN. I would like to inquire whether they do not generally irrigate in Latah and Nez Perces Counties? Is it certain that irrigation would not be beneficial to them?

Mr. STRAUGHAN. The reports from those counties state that if the Indian reservation is thrown open to settlement, irrigation will operate to advantage on some sections of that reservation. From Kootenai County they also report some few districts where the artesian-well system will probably apply.

The CHAIRMAN. Latah and Nez Perces counties have plenty of streams passing through them if they desire to irrigate?

Mr. STRAUGHAN. Yes; but the reports mostly state briefly that no irrigation is needed; none required.

The CHAIRMAN. There are some gentlemen here from that section who wanted to make a statement in regard to it. Are those the reports? [Indicating the papers in the hand of Mr. Straughan.]

Mr. STRAUGHAN. Yes, those are the type-written copies of the original reports.

The CHAIRMAN. Will you explain the maps which you prepared?

Mr. STRAUGHAN. Ada County, for example, pretty much explains itself. There is a general description and recapitulation accompanying

each map. (This is embraced in the testimony.) We realized that the time of the committee was limited, and that it had to cover a very large territory in its investigations. Therefore, we prepared a comprehensive and brief statement.

STATEMENT OF C. B. COBURN, OF LEWISTON.

The CHAIRMAN. How long have you resided at Lewiston?

Mr. COBURN. About twenty-seven years.

The CHAIRMAN. That is in northern Idaho?

Mr. COBURN. Yes.

The CHAIRMAN. What streams of water pass through the agricultural section of Nez Perces and Latah Counties?

Mr. COBURN. The Clear Water and Snake rivers pass through Nez Perces.

The CHAIRMAN. Is Latah County an agricultural county?

Mr. COBURN. Yes.

The CHAIRMAN. Are there streams from the mountains passing through that county?

Mr. COBURN. Yes; from the north side of the Clear Water.

The CHAIRMAN. What are the streams?

Mr. COBURN. Different branches of the Clear Water. What they call the Potlatch Creek is quite a large stream coming in from the north.

The CHAIRMAN. What is the rain-fall that you have in those counties?

Mr. COBURN. I can not give you the statistics, but it is about the same as it is in this county.

The CHAIRMAN. You raise crops there without irrigation?

Mr. COBURN. The small grains generally, particularly in Latah and Idaho Counties. They have never adopted any system of irrigation. The table-lands in Nez Perces are drier.

The CHAIRMAN. Latah and Idaho Counties have sufficient rain-fall?

Mr. COBURN. Generally, until this season.

The CHAIRMAN. Have they not had it this season?

Mr. COBURN. This is the only exception.

The CHAIRMAN. They have sufficient rain-fall for small grain?

Mr. COBURN. Yes.

The CHAIRMAN. The Nez Perces County table-lands are higher and drier?

Mr. COBURN. Yes; those lands could be irrigated advantageously.

The CHAIRMAN. Is the rain-fall so small that you do not get a good crop of grain each year?

Mr. COBURN. Not each year.

The CHAIRMAN. How often do they fail to get a good crop?

Mr. COBURN. Every other year. As you get back toward the foothills, toward the mountains, they have never had a failure.

The CHAIRMAN. That is where the snows are melting?

Mr. COBURN. Yes.

The CHAIRMAN. How is it with regard to all around crops—potatoes, corn, etc.—farm products?

Mr. COBURN. They are good.

The CHAIRMAN. Do they grow under irrigation?

Mr. COBURN. They do up in the drier plateaus.

The CHAIRMAN. Would the country be materially improved by irrigation?

Mr. COBURN. Very much, indeed.

The CHAIRMAN. Have the people considered that subject?

Mr. COBURN. They have.

The CHAIRMAN. Have the people practiced it any?

Mr. COBURN. We have done so, and the lower bench of the Clear Water is irrigated to quite a considerable extent.

The CHAIRMAN. How much land is under cultivation? Take the counties of Idaho, Latah, and Nez Perces—the counties under that water-shed?

Mr. COBURN. I am unable to give you the figures.

The CHAIRMAN. How much have you in Nez Perces?

Mr. COBURN. There must be 25,000 acres.

The CHAIRMAN. How much in Latah?

Mr. COBURN. Latah has fully as much, if not more. The Indian reservation cuts out a large portion of the best part of Nez Perces County—the reservation which they are now taking steps to have thrown open to settlement.

The CHAIRMAN. How many Indians are there?

Mr. COBURN. About 1,200. They are now taking steps to locate the land in severalty, and they have been for the last two months.

STATEMENT OF GOVERNOR E. A. STEVENSON, OF BOISÉ CITY.

Senator JONES. I would like to have go in the record a short statement about the time this town was settled, the character of the land when the people came here, its character before the water was put on it, and perhaps the governor would be the proper person to state those facts so far as he may know them.

Mr. STEVENSON. This town was settled in 1863, but very little agriculture was attempted until 1864 or 1865. When I first saw this town this portion around here was as poor a sage-brush place as you would find in Idaho—a miserable sandy place that nobody imagined would grow anything. This ranch that we went over this morning, Mr. Moore said he rode over it when it was a regular bed of sand, and this year they have raised 5 tons of red clover to the acre on that ranch.

The CHAIRMAN. Have they cut that much?

Mr. STEVENSON. Yes. It was that way all along this valley. There was a little strip along the river where some grass grew and where there were some willows and trees. The first men who came here settled on that low bench land, and they have the poorest farms in the country. Those who went back on the sage-brush plains have land that is worth five times as much as the other. And so it is in Washington Territory, at Walla Walla. All those men who went on the Touchet, and all those streams, have poor farms; those who went on the high lands have good farms. But this land without irrigation would produce nothing. It might, if it should rain in the fall, produce a crop of rye, but there is no dependence to be placed on it. But rye will grow almost any place. Right up between this and the penitentiary is a tract of country that we consider better than any place. It was covered with gravel. Now it is almost as fine a farm as there is any place. Mr. Costin told me that he cut, on a portion of that land, 7 tons to the acre.

I have had some experience with irrigation. My partner and I dug a ditch 22 miles long down on the Payette River. We took some water on to some desert land that we have there, and in five years we have raised

orchards with lots of fruit. I have cut the grass there twice this year already, and there is a regular forest where there was not a tree in sight in the country. In a short time, five years, these trees were 5 inches through.

Senator JONES. What kind of trees do you grow?

Mr. STEVENSON. Apple, pear, plum, peach, apricot, prune, and these poplar trees; box-elder, walnut, locust and all these different varieties. I took small trees in a two-horse wagon down there. I told some persons that five years ago I took in a two-horse wagon all the trees that are growing there to-day, and they were thunder-struck. A man can not imagine that it could be done. But it is marvelous how the trees grow there.

The CHAIRMAN. How much land is covered by your ditch?

Mr. STEVENSON. I suppose it would cover, if the ditch were extended, 50,000 acres. I think it covers 40,000 acres now.

The CHAIRMAN. To what extent is that land under cultivation?

Mr. STEVENSON. I have only about a hundred acres under cultivation. I have 2,200 acres of land.

Senator REAGAN. State what that land was worth before it was irrigated and what it is worth now.

Mr. STEVENSON. It is not worth anything unless it is irrigated.

Senator REAGAN. What is it worth now that you can apply water to it?

Mr. STEVENSON. I do not know the value of it.

The CHAIRMAN. Have you ever farmed in other countries so that you can compare this with other countries?

Mr. STEVENSON. Yes; in California. I do not think you can raise cereals where you have to irrigate and compete with a country that does not. But in all other kinds of crops, vegetables, I think we can.

The CHAIRMAN. How about fruits?

Mr. STEVENSON. Yes; we raise all kinds of fruits and vegetables. We raised those potatoes which are below, which you do not see in other countries. [Referring to an exhibit of vegetables in the courthouse.]

The CHAIRMAN. Does not an irrigated country require more population?

Mr. STEVENSON. Certainly; the holdings in an irrigated country should be small. A small farm will support a good family if it is well irrigated. The system of irrigation is crude. They do not understand it. Some give too much water and some too little.

The CHAIRMAN. What would be the proper extent of a farm for a man and his family to attend to—an ordinary family—to the best advantage?

Mr. STEVENSON. From 80 to 160 acres. Some farmers might live on 60 acres. But I think it would be better for the country to cut it up into 80 acres.

The CHAIRMAN. Would it not be better for the country to have it cut up into 40 acres? Would not 40 acres do well?

Mr. STEVENSON. Yes; 40 acres would make a good home if well cultivated. Now, on the Payette River the supply of water is abundant without storage, and will water all the land on it. There is a large amount of water there now. But on the Boisé River it would need storage. There is plenty of water here with proper storage facilities to cover the whole country. I am speaking of Lewiston. Around the city of Lewiston they could not raise fruit in the garden without irrigation. They irrigate there altogether. And on that table land around

Lewiston they could raise double as much in five years as they could without irrigation. There is an immense supply of water there.

The CHAIRMAN. Is that true of portions of Washington Territory where they do not irrigate now?

Mr. STEVENSON. Yes; it is true of those portions of Washington Territory about Walla Walla. Those crops suffer for want of water. There cereals and vegetables some years can not grow without irrigation. Frequently they can get along and get a good crop; but most frequently it suffers for want of water.

Senator JONES. How is it along that ditch which you and your partner constructed 22 miles in length?

Mr. STEVENSON. That takes water to perhaps 40,000 acres of land.

Senator JONES. There are 40,000 acres of land under it to which it could supply water?

Mr. STEVENSON. Yes.

Senator JONES. When did you cultivate the land tributary to that ditch?

Mr. STEVENSON. Six years ago.

Senator JONES. How much of it is under cultivation?

Mr. STEVENSON. I do not think there is more than 4,000 acres—there is not that much—3,000 acres.

Senator JONES. Have you any objection to stating the cost of that ditch?

Mr. STEVENSON. Twenty thousand dollars cash.

Senator JONES. How long is it?

Mr. STEVENSON. Twenty-two miles.

Senator JONES. What is the size of the ditch?

Mr. STEVENSON. Six feet on the bottom and 10 at the top.

Senator JONES. How much water does it carry?

Mr. STEVENSON. Two feet.

The CHAIRMAN. With what fall?

Mr. STEVENSON. An eighth of an inch to the rod. It has a large fall, but it does not cut the banks.

Senator JONES. What disposition do you make to the holders of adjacent lands? Do you sell the right to the water or do you give it to them?

Mr. STEVENSON. These men are all poor men, and have just commenced. We have never sold them any water if they wanted it. I have never established a right to the water, because I did not wish to get into the position of being compelled to give water when I did not wish to do so. Then, too, if I sell the water I have to pay taxes on the ditch, while I do not by not selling, and the rent which I would get for the water would not come up to the amount I would have to pay in taxes; so I do not sell it.

Senator JONES. What I wish to understand is your intention, whether you wish to part with the right to the water in that ditch to the owners of the adjacent lands, permitting them to have the water from year to year. I would like to know your intention if you have no objection.

Mr. STEVENSON. The Fayette River, out of which this ditch comes, has an immense amount of water in it. There is no monopoly of the water at all. But there were two or three of us who started in and took up some desert land down there, and we took a section apiece. After we got the ditch partly done, the other parties thought it would cost too much, and they sold out to us. So that we have the ditch and the land there. I did not make any arrangements about the selling of water.

Senator JONES. Your prime purpose was to reclaim this land ?

Mr. STEVENSON. Yes ; they require us to have about an inch to the acre, require us to provide that.

Senator JONES. But you have a little over 2,200 acres of land yourself ?

Mr. STEVENSON. Yes.

Senator JONES. And you have water enough for 40,000 acres ?

Mr. STEVENSON. The ditch would have to be enlarged to cover that amount of land. But if there were any monopoly of the water and no water there but this, then I would see the point in your question. But there is nothing to hinder anybody from getting the water out of the river.

Senator JONES. What I am trying to bring out is whether you are willing to sell the right to the water ; whether, if I owned adjacent land to that ditch, you would sell me outright water enough to irrigate my land—make a contract, a final one, to furnish it to me from year to year ? Under the water laws of the Territory you are under no obligation to supply water unless you wish to do so. I wanted to know what your purpose was. I will state freely that I think the right to the water ought to go with the land. I do not think one person should be permitted to prevent another getting the water, and my inquiry looks to the reason for constructing ditches in this country ; not specially in your case, but the general drift of the whole business.

Mr. STEVENSON. In some localities they have built ditches and have been selling the water. So far as my experience goes the men who have built ditches have not found it profitable.

Senator JONES. Do they sell water ?

Mr. STEVENSON. Over here on the river they charge so much per acre to irrigate the land.

Senator JONES. And that gives a man the right to have the water for a year ?

Mr. STEVENSON. Yes.

The CHAIRMAN. Does he buy a perpetual right, or is it yearly ?

Mr. STEVENSON. Yearly.

Senator JONES. Then the owner of the ditch can cut him off if he should choose to do so ?

Mr. STEVENSON. Yes.

Senator JONES. Does the owner of the ditch fix the price for the water ?

Mr. STEVENSON. No.

Senator JONES. But he has the right to close out the users ?

Mr. STEVENSON. Yes, all of them.

Senator JONES. What is the yield per acre of grain-growing land in this country ?

Mr. STEVENSON. I think 40 bushels to the acre is a good fair yield, and 50 bushels of oats on irrigated land.

Senator JONES. Is the expense of cultivating an irrigated crop greater than the expense where it is not irrigated ?

Mr. STEVENSON. Yes.

Senator JONES. In what does that expense consist ?

Mr. STEVENSON. In the irrigation. I suppose one man, if he had his land properly fixed and it was principally in grass, could irrigate 100 acres. If he had it in different kinds of crops he could not irrigate more than 40 acres.

Senator JONES. Is it irrigated by flooding ?

Mr. STEVENSON. If it be in grass it is ; but in vegetables it is in rows.

Senator JONES. Have you the water through the fields in a permanent way, or do you every year have to construct your apparatus for distributing the water?

Mr. STEVENSON. It is temporary.

Senator JONES. That is one of the expenses of cultivating crops?

Mr. STEVENSON. Yes, one of the expenses.

Senator JONES. What kinds of crops are cultivated in this valley contiguous to this town?

Mr. STEVENSON. Wheat, oats, barley, potatoes, some corn, and all kinds of vegetables and fruits.

Senator JONES. Of grass and hay crops what kinds?

Mr. STEVENSON. Clover, timothy, orchard-grass, and alfalfa.

Senator JONES. I believe you said something of the yield of red clover on some of these fields. Can you make any statement about the yield of alfalfa and timothy?

Mr. STEVENSON. Of alfalfa you can cut $2\frac{1}{2}$ tons to the acre. But I have known two instances where they have cut 10 tons a year from an acre.

Senator JONES. That is an extraordinary yield, I suppose?

Mr. STEVENSON. Yes, I think it is.

Senator JONES. What would you consider a fair average yield?

Mr. STEVENSON. Six tons I would consider a fair yield.

The CHAIRMAN. Have you observed whether or not the cutting away of the timber on the hills has any effect upon the streams?

Mr. STEVENSON. I presume it has, but I do not think it is perceptible to me.

The CHAIRMAN. It has not been perceptible in this Territory so far as your observation has gone?

Mr. STEVENSON. No. On these streams up on the mountains, where they are very heavily timbered and not much population, the timber is set afire.

The CHAIRMAN. Are there forest fires raging in Idaho as well as in Montana?

Mr. STEVENSON. Yes, and everywhere this year.

The CHAIRMAN. Have you any suggestion to make in regard to the management of this timber by the Government?

Mr. STEVENSON. I think the Government should assume control of those lands and have agents to look after them, allowing the citizens to cut as much as they want to use. That, I think, would be better than the present system. These fires will destroy more timber in one year than all the settlers on the public lands in Idaho have taken. I suppose they will this year.

STATEMENT OF MILTON KELLY, OF BOISÉ CITY.

The CHAIRMAN. How long have you resided here?

Mr. KELLY. I have resided here since the fall of 1862, or at least in the Territory. I have resided here a portion of the time, and a portion in North Idaho. I am well acquainted with the character of this valley—Snake River Valley.

The CHAIRMAN. Go on and state such facts as you may think important relating to the subject of irrigation.

Mr. KELLY. I want to say this first: A large portion of this valley is a lava country. It is a desert country, and will be until it is covered over with 3 or 4 feet of good soil. But there are other portions that are

fine agricultural lands. Considerable of it is hilly, and that probably will never be irrigated. The agricultural lands commence on this side of the Shoshone. The first important area of land is at Mountain Home here. No water can be brought onto that land except it be brought from the Boisé River, or be saved in lakes and ponds from Cañon Creek or Rattlesnake Creek. It would be a great object to save that water and distribute it over that area of land, which is fine agricultural land.

The CHAIRMAN. Do those lakes flow a large amount of water in flood time?

Mr. KELLY. Yes; but nearly dry up in the dry part of the season. I am talking of this side of Snake River; I will talk of the other side after awhile.

When we get below here on the south side of the Boisé River, until we get nearly opposite this point, we have this plain that is north or west of the railroad on which you entered the city. It extends down to the Snake River. That area of country is 12 or 15 miles wide and some 30 miles long. It is fine agricultural land if it were covered with water. The water to be put on that land must be taken from the Boisé River. I estimate that portion of the country to-day would employ, if it were improved as it may be, at least five thousand laborers more than are there. I do not mean children and families, I mean that many laborers, hard laborers, would be employed to cultivate the land. That is the portion of land that ought to receive your attention. It is in this county.

The next arable land that needs irrigation is the land on this side of the Boisé River, and from here down below Middleton, some 25 miles. It needs water on it. There has been some taken out by the farmers, but there has been no heavy ditch taken out. There is a large area of land lying there, and it is as good land as this in Boisé City, and it has never been watered. If that land were watered it would employ all of three thousand more laborers than we have.

Below this place, where I say the town of Middleton is, on the north side of the Boisé River, is another area of land. If we had a map of the county I could show it to you, so that you could understand it.

The CHAIRMAN. We understand it very well. We have already been over a considerable area of the Northwest.

Mr. KELLY. It needs water very much. They have taken out a ditch there to cover considerable of the land. But that will employ a good many laborers when it is cultivated. Then on the Payette River, of which Governor Stevenson was speaking, on the south side of that river eight of us tried to build a ditch, and we spent \$20,000. Finding that it would take \$50,000 the ditch lies in abeyance. We have given it to the settlers—a ditch we dug 30 miles long. There is a large area below this that we were not able to reach, or thought we were not. We did not abandon the enterprise, but we had to abandon the land and give up our money. There is a large area, fifty sections, of land there which is probably as fine land as is in this country, but it needs a ditch. And there is on the north side a large area of fine land that needs to be irrigated. I do not know how many sections there are—thirty or forty sections; probably fifty. I have been over it a number of times, but I do not want to make an estimate of the land. On those sections of land of which I speak we could employ in raising fruits, vegetables and grain, etc., at least, ten thousand laborers; and if we could get favorable rates with the railroad we could find a market for the products.

I would like to ask you what the Government intends to do for us. I want to know what is the object of this irrigation survey.

The CHAIRMAN. The object is to ascertain how much desert land there is, how important a question it is, what can be done in the way of getting information for the Government and for the people, so that the people may be able to utilize what they have, estimating the cost of constructing reservoirs and ditches, reservoir sites, etc. I do not know that the Government will continue to do that. It has commenced to do it, and we are investigating the matter to see whether it ought to be continued.

STATEMENT OF A. D. FOOTE, OF THE U. S. GEOLOGICAL SURVEY.

The CHAIRMAN. What is your occupation?

Mr. FOOTE. I am a civil engineer, in charge of the Idaho division of the Irrigation Survey.

The CHAIRMAN. You have been engaged in making some preliminary examinations of the Snake River and the lands that may be improved by it? State in your own way the result of your investigations in this portion of Idaho, or such portions as you have examined. State what you found, what land can be irrigated, what water is to be gotten, and how.

Mr. FOOTE. Taking the Snake River Valley and beginning at the lower portion. From my knowledge of the country, obtained before I was in the Government service and since, I should commence with the Weiser River Valley. The Weiser River will supply sufficient water with storage capacity, and I am confident the storage capacity can be found. Then the Payette River furnishes one of the best streams for water outside of the Snake, and the large lakes at its head make the storage of water there a matter of absolute certainty, and at very small cost.

The next is above the Bois , which has some 400,000 acres of irrigable land and water supply sufficient for a full supply for about sixty days each year for irrigation, and from actual surveys is known to have ample storage room to furnish water for the balance of the year.

The CHAIRMAN. Are there good storage facilities on the Bois ?

Mr. FOOTE. Yes; the location found by actual surveys.

The CHAIRMAN. To supply all the land that can be covered by its flow?

Mr. FOOTE. Yes; to supply all the land that can be covered by its flow. I do not know how many acres are in Camas Prairie.

The CHAIRMAN. The stream goes down and empties into the Snake, does it not?

Mr. FOOTE. Yes; it is pretty high, and it is difficult to say how large an area can be irrigated there. I do not know, but I think there are 150,000 acres in Camas Prairie, of which a large portion, not to exceed 25,000 acres, can be irrigated by storage. There is a little natural supply, but the land lies in such a position that it gets very little irrigation,

The CHAIRMAN. Can it be reached by Snake River direct?

Mr. FOOTE. No; it is too high. There is not much drainage into it. The Bois  River furnishes water for about 75,000 acres without storage. That is, the land that lies immediately under it.

The CHAIRMAN. Do you meet with the basaltic rock on that side?

Mr. FOOTE. Yes. The extent of country between the Bois  Valley, running all the way up the Snake River to Eagle Rock, is covered more

or less with lava. About two-thirds of it is most excellent land, and can be covered by a canal, probably, starting near Eagle Rock.

Senator JONES. Is that land which you call excellent covered with lava?

Mr. FOOTE. No; the lava is underneath that which is excellent.

Senator JONES. You mean it is underlaid with lava?

Mr. FOOTE. More or less of it is covered with lava.

Senator JONES. Where it underlies the ground it is worthless?

Mr. FOOTE. No; where it overlays it is worthless. It is very valuable land where it is underlaid, the richest that we have. I do not know how many acres we have in that strip. It could be supplied from the Snake; and northward from that, still further up the river, is a tract which can be supplied with storage to a great extent from Lost River, Camas Creek, Birch Creek, and upper waters of the Snake. Above Eagle Rock the land can be supplied by the Snake and other rivers. From canals actually constructed and actual surveys it is known that a district consisting of 500,000 acres, lying on the south side of the Snake and above the American Falls, can be covered. This estimate is based upon actual surveys and ditches constructed at the present time. That area can be covered by the waters from the Snake River and its tributaries. From actual surveys it is known that there is storage capacity on the Payette, Weiser, and Boise Rivers. The lowest measurement of the Snake River at Eagle Rock, in this valley, is about 5,000 cubic feet per second, and from actual surveys we know at this time that there are reservoir facilities for 5,000,000 acre-feet.

The CHAIRMAN. That is a foot deep covering 5,000,000 acres each way?

Mr. FOOTE. Yes. And we have reason to believe that that quantity can be nearly or quite doubled. And there is a tract of land of 50,000 acres to be irrigated from the Owyhee River.

The CHAIRMAN. Where is that situated, in this Territory or in Oregon?

Mr. FOOTE. That is in Oregon.

The CHAIRMAN. It is in this great valley.

Mr. FOOTE. Yes. The Owyhee is a tributary of the Snake. And on the Malheur I do not know how many acres there are. That I shall have to find out, but as yet I have not been in that country.

The CHAIRMAN. How long have you been specially engaged in making these general examinations for the Government?

Mr. FOOTE. It is only three months.

The CHAIRMAN. Then your knowledge comes from your previous experience?

Mr. FOOTE. Most of my knowledge I had before I was employed by the Government.

The CHAIRMAN. Of course, you have not examined it critically, but what amount of land do you estimate can be irrigated from the Snake River and its tributaries?

Mr. FOOTE. I did not have the maps to make that estimate, and I will have to give you that later.

The CHAIRMAN. Can you state whether or not there could be sufficient water stored at a reasonable cost to irrigate the land of which you have spoken?

Mr. FOOTE. From my own knowledge and that obtained from others I am prepared to state that a sufficient amount of water can be stored to cover 5,000,000 acres of land in the Snake River Valley, at a storage cost of less than a half dollar an acre.

Senator JONES. That is the item of storage alone ?

Mr. FOOTE. That is the item of storage alone.

The CHAIRMAN. In some places the construction of reservoirs would cost more and in some less ?

Mr. FOOTE. Yes; but it would not average more than that sum.

Senator REAGAN. Do you mean general ditches or ditches for distribution ?

Mr. FOOTE. The ditches in addition to that would be from \$3 to \$6.

The CHAIRMAN. Would it go higher than \$5 or \$6 ?

Mr. FOOTE. I would not look at any enterprise that would cost more than that.

The CHAIRMAN. What would you estimate to be the cost of irrigating these 5,000,000 acres ?

Mr. FOOTE. From my experience I would estimate, and very closely too, that a million acres can be irrigated for \$2 an acre.

The CHAIRMAN. Do you add a half-dollar to that for storage ?

Mr. FOOTE. No; that is including the storage. But for the rest of the 5,000,000 acres I do not think we can do it for twice that.

The CHAIRMAN. Do you think you can do it for \$5 an acre ?

Mr. FOOTE. Yes; between \$4 and \$5 is the estimate.

The CHAIRMAN. Then 1,000,000 acres of the five can be irrigated at \$2 an acre ?

Mr. FOOTE. Yes.

The CHAIRMAN. And for the other 4,000,000 acres what ?

Mr. FOOTE. I think it can be done for \$5 an acre. Our water all comes in one big stream.

Senator JONES. Are there 5,000,000 acres of land to which water could be carried ?

Mr. FOOTE. Yes; there are six.

The CHAIRMAN. You can not state whether you can reach six million acres ?

Mr. FOOTE. I cannot state that positively.

The CHAIRMAN. What is your opinion ?

Mr. FOOTE. It is my opinion that we can without any doubt.

The CHAIRMAN. Do you think you can reclaim 6,000,000 acres of this valley ?

Mr. FOOTE. I think so. I think next year, if we have a chance, we can prove that.

Senator JONES. Will those 6,000,000 acres include all the irrigable land in the country ?

Mr. FOOTE. Practically. The surveyor-general was just telling me that the northern counties would need irrigation. The Bear River is not included in this estimate at all.

Senator JONES. You have not estimated the amount of land in that valley ?

Mr. FOOTE. No; we have nothing to do with that. That drains the other way, out of my basin.

Senator JONES. You have estimated what ?

Mr. FOOTE. The drainage into the Snake River.

The CHAIRMAN. What proportion of the Territory does not drain into the Snake River ?

Mr. FOOTE. I do not know how much irrigable land is in that Territory north; they say none. I do not know anything about it.

The CHAIRMAN. You have not examined that ?

Mr. FOOTE. No. In the Bear Lake country I know there is a good deal of land to be irrigated.

The CHAIRMAN. You do not include Bear Lake in your estimates ?

Mr. FOOTE. No ; I include only the Snake River Valley.

The CHAIRMAN. Do you include in that estimate the small valleys back in the mountains that need irrigation ?

Mr. FOOTE. If they flow into the Snake River.

The CHAIRMAN. In places, in carrying out your scheme to complete it, will there be small ditches and reservoirs necessary—ditches that would be independent of the large ones ?

Mr. FOOTE. Yes ; I should think it would encourage just those things.

The CHAIRMAN. From your examination of the country state whether all the enterprises are large, or some large and some small ?

Mr. FOOTE. It includes all.

The CHAIRMAN. Are there many small enterprises ?

Mr. FOOTE. I think a great many. There are too many altogether of the small ones for an economical use of water.

Senator JONES. What Senator Stewart wishes to know is, whether or not in this Snake River basin there are many localities where irrigation could be practiced, the water brought on to small tracts of land all along, before organizing big companies and having long and expensive ditches ?

The CHAIRMAN. I do not want to have it stated that they go along the river ; I wish you to state whether or not there are small places where water can be used instead of taking it out of the rivers and wasting it.

Mr. FOOTE. Yes ; there are a great many small ditches taken out of the irrigating streams that irrigate all the land. It would not be taken out of the large streams. Every stream along the southern line of this Territory would carry a little water ; but there might be a reservoir to store the water, and each one of them would irrigate a good deal of land in addition to what the large one would irrigate. They would run further up the stream than the large canal.

The CHAIRMAN. When this survey shall have been completed, tell whether or not there will be places outside of that big stream.

Mr. FOOTE. Yes ; a good many of them, and we do not allow anything in these tributary streams except what I have named.

The CHAIRMAN. They can make their small storage reservoirs in the foothills above and cultivate the small patches of land without interfering with your scheme ?

Mr. FOOTE. Yes.

Senator JONES. Those things could be done at a comparatively small expense, I presume ?

Mr. FOOTE. Yes ; in fact are all nearly done. Perhaps I had better explain our method of irrigation. Where the ground is not already known, where lines have not been already run, but where a tract of land can be covered, our general plan is to run lines for large canals around the valley and see just how much land can be covered and how much water will be required. But in places like the Boisé and Payette the surveys have been already made, and there we can tell almost how many acres of land and how much water will be needed to irrigate the land with the cost attached.

To the north of Eagle Rock, the South Fork, the canals have been already constructed to a large extent, and they can be enlarged. We know what has been done there, and how much water it will take. But there is a good opportunity to take water out of the Snake River. We put a line there and made our estimates as we went along. We run down 74 miles of line with the necessary drop into Blackfoot River, just as though we were going to construct a canal, and there 200,000

acres of land can be reclaimed for \$230,000. That much is settled. Our plan is to go clear around the valley in that way, so that the Government may be able to show to anybody what can be done in the valley.

The CHAIRMAN. Have you any storage reservoirs at the headwaters of the Snake River, reservoirs which you can name?

Mr. FOOTE. I want to make a more thorough reconnaissance before I testify on that point.

The CHAIRMAN. We do not ask for detail?

Mr. FOOTE. I have been up there, and I can say that the opportunities for storing water are something enormous. The lakes there are so formed that there is a great drainage into them.

The CHAIRMAN. Is there a large number of lakes up there?

Mr. FOOTE. Yes.

The CHAIRMAN. Of much size?

Mr. FOOTE. Some of them 25 or 30 miles long.

The CHAIRMAN. About what altitude?

Mr. FOOTE. Six, seven, or eight thousand feet.

The CHAIRMAN. Where there is deep snow-fall and deep woods?

Mr. FOOTE. Yes.

The CHAIRMAN. Do those lakes drain down pretty low, or do they contain water through the whole season? How as to the rise and fall of those lakes?

Mr. FOOTE. They do not rise much, because the water runs out as fast as it gets in. But every basin of which I speak has a reservoir, and dams should be put in to make the water rise. I know of one place where there are meadows, basins of natural lakes scattered around, where 50 feet of water in depth could be stored at a cost not to exceed \$100,000.

The CHAIRMAN. Are there any inhabitants around it?

Mr. FOOTE. Not at the present time. I know of other things better than that, larger than that.

The CHAIRMAN. Are many of them obstructed by claims at this time?

Mr. FOOTE. I think not any; very few. They are too high. The snow is too deep for the people to live there with their cattle. This year being a dry year they have gone in there and are feeding their cattle.

Senator JONES. These lakes of which you speak are all at the head of the Snake River?

Mr. FOOTE. Yes.

Senator REAGAN. I understood you to say that you had been engaged in this irrigation survey as a Government employé for three months.

Mr. FOOTE. Since the middle of May.

Senator REAGAN. Were you previously to that time surveying for canals in this country?

Mr. FOOTE. Yes.

Senator REAGAN. But not on Government account?

Mr. FOOTE. No, on private account.

Senator REAGAN. Do you find difficulty in separating your work done on private account from that done on Government account?

Mr. FOOTE. I am not doing any private work now. No one is allowed to do it when in Government employ.

Director POWELL. I know the survey is not yet completed, but give us an idea of Jackson Lake as a reservoir.

Mr. FOOTE. My notes give it as 30 miles long, from 5 to 8 miles wide,

and by means of a dam the water can be made to rise 50 feet. That can be built for \$250,000 or less, and it will give an area of 150 square miles and a capacity of 5,000,000 acre-feet. It is my intention to go and prove my work.

Senator JONES. That is one lake.

Mr. FOOTE. One lake.

The CHAIRMAN. Is the snow-fall sufficient there?

Mr. FOOTE. Yes, if it be half what they call it, 8 feet. If it be 4 feet it will fill the lake twice every year. You see the drainage is away up in the middle of the National Park.

The CHAIRMAN. Would it interfere with the National Park if it were dammed?

Mr. FOOTE. No; it is too far below.

Senator REAGAN. State how many different plans of irrigation have been adopted along the valley of the Snake and Boisé Rivers and these other streams; how many different enterprises are now in operation.

Mr. FOOTE. There are a good many of them. They are building them everywhere.

STATEMENT OF L. F. CARTEE, OF BOISE CITY.

The CHAIRMAN. How long have you resided in Boisé?

Mr. CARTEE. I came here in the spring of 1863 and have been in the Territory ever since.

The CHAIRMAN. Explain the results of irrigation in this vicinity.

Mr. CARTEE. The best explanation that can be given is the fruit and vegetables which you see around you.

The CHAIRMAN. What do you see around us?

Mr. CARTEE. This sage-brush land is capable of producing anything that can be raised in this latitude anywhere, not only all the varieties of fruits, but of all the cereals.

The CHAIRMAN. Describe the cereals and fruits that are raised here, giving the quantity, character, etc.

Mr. CARTEE. I do not know how I can answer your question better than to say that we raise all kinds of fruits, nearly—apples, pears, peaches, and grapes. I have forty different varieties of grapes on my place, and they nearly all ripen, except the Catawba. That does not ripen because of the shortness of the season.

The CHAIRMAN. You say this land produces a grape of a good quality?

Mr. CARTEE. A fair quality; better than any of the eastern grapes that we have. Of course, the quality is not equal to the California grape.

The CHAIRMAN. You have been surveyor-general of the Territory?

Mr. CARTEE. Yes, for fourteen years.

The CHAIRMAN. And you have been farming yourself?

Mr. CARTEE. Yes.

The CHAIRMAN. What is a fair crop of wheat here on irrigated land?

Mr. CARTEE. From 25 to 50 bushels.

The CHAIRMAN. What is a fair crop of oats?

Mr. CARTEE. From 30 to 60 bushels; occasionally 70 to 80 bushels, but that is exceptional.

The CHAIRMAN. How is barley?

Mr. CARTEE. The same as wheat—25 to 50 bushels.

The CHAIRMAN. And timothy hay?

Mr. CARTEE. On an average of about 2 tons to the acre.

The CHAIRMAN. And alfalfa?

Mr. CARTEE. Six tons.

The CHAIRMAN. How about red clover?

Mr. CARTEE. About the same as alfalfa, about 6 tons.

The CHAIRMAN. And your potatoes?

Mr. CARTEE. Well, probably 600 bushels to the acre is a fair aggregate.

The CHAIRMAN. Is this land here good land for raising apples?

Mr. CARTEE. It is first rate. It is the finest apple country in the world.

The CHAIRMAN. What varieties of apples do you raise?

Mr. CARTEE. All apples do well here; you can hardly find an exception.

The CHAIRMAN. Do they grow to a large size?

Mr. CARTEE. Very large.

The CHAIRMAN. Are the trees heavily loaded?

Mr. CARTEE. Too heavily loaded.

The CHAIRMAN. Do you raise peaches?

Mr. CARTEE. Yes.

The CHAIRMAN. How do they grow?

Mr. CARTEE. They grow well.

The CHAIRMAN. How about prunes?

Mr. CARTEE. Plums and prunes do remarkably well, better than in any country in which I have been.

The CHAIRMAN. And pears?

Mr. CARTEE. Pears are very good.

The CHAIRMAN. Do you raise all varieties of pears?

Mr. CARTEE. Yes, there is very little difference in the result. I have never made a failure of any variety that I have tried to cultivate, and I have made an effort with all varieties.

The CHAIRMAN. How are the small berries?

Mr. CARTEE. They do finely.

The CHAIRMAN. And you raise all kinds?

Mr. CARTEE. Yes.

The CHAIRMAN. What kind of land would be suitable for an ordinary farmer to cultivate in the highest style, irrigated, and how much would he need to support his family, well, as well as he could with a farm of 160 acres in the Mississippi valley?

Mr. CARTEE. I would say from 25 to 40 acres.

The CHAIRMAN. Can a man make a living here on 25 acres of land if he cultivate it well?

Mr. CARTEE. Yes. Our great drawback here is transportation. For instance, if we were to send a car-load of freight from here to Illinois, they will charge more than they would from San Francisco to Illinois, which is a great injustice.

Senator REAGAN. Does the line from San Francisco to Illinois pass through this place?

Mr. CARTEE. No.

The CHAIRMAN. Is this a good stock country?

Mr. CARTEE. Very good.

The CHAIRMAN. What would be the condition of the farmers here if the land were under cultivation and they had the use of the hill lands for pasturage? Would they produce a large amount of meat for shipment?

Mr. CARTEE. Yes.

The CHAIRMAN. If the farmers had the forage with which to fatten their cattle in the winter they could extend their meat production very largely, could they?

Mr. CARTEE. Yes; and it would be really one of our best material interests.

The CHAIRMAN. It would be in a condensed form?

Mr. CARTEE. Yes; and we could get it out of the country at less expense.

The CHAIRMAN. The cattle business has been the principal business here except farming?

Mr. CARTEE. Yes.

The CHAIRMAN. Would that increase the reclamation of the valleys?

Mr. CARTEE. Largely increase it.

The CHAIRMAN. How does the winter supply for cattle here compare with the summer supply?

Mr. CARTEE. In the meat interest it has not been so good, because we have not had water range sufficient to keep up the pasturage. Our wild grasses do not stand that close feeding that they do in the east.

The CHAIRMAN. There is an abundance of summer supply?

Mr. CARTEE. Yes.

The CHAIRMAN. If you had forage you think this would be a much better stock country than now?

Mr. CARTEE. Of course it would be, in every sense of the word.

The CHAIRMAN. If your transportation were reasonable would you be able to ship your fruits to the Atlantic sea-board and the eastern cities?

Mr. CARTEE. We could compete with our own growers; but whether we could do so with foreign growers is a question.

Senator REAGAN. Where have you found a market for your fruits?

Mr. CARTEE. Our large fruit market has been in the mines; but that has dropped off.

The CHAIRMAN. What character of shipment do you make to Chicago and New York?

Mr. CARTEE. Probably pears of all varieties, and plums, and prunes.

The CHAIRMAN. Do you raise apricots and nectarines?

Mr. CARTEE. No; apricots do not grow here.

The CHAIRMAN. Do you raise figs?

Mr. CARTEE. I have raised a few—had a few trees—but the winter is too severe.

The CHAIRMAN. But pears and prunes, grapes and plums, you could ship?

Mr. CARTEE. Yes. I sent up this morning some five or six different varieties of prunes.

The CHAIRMAN. You wish to say something further in regard to irrigation. Will you state any fact which may have occurred in your experience material to this subject?

Mr. CARTEE. My idea of this subject of irrigation is that the waters of Snake River are not so available for any section west of Wood River or Bruneau, because the expense of taking it out would involve too large an expenditure, and we have ample small streams which could be utilized by building reservoirs, and from them we could irrigate the whole plain.

The CHAIRMAN. You think that by reservoirs there is a large amount of land that might be brought under cultivation by taking the water from the small streams, and that that could be done at no great expense?

Mr. CARTEE. Yes.

The CHAIRMAN. Suppose that surveys were made and the information obtained, so that the people would know what they could do,

would that enable settlers to reclaim a good deal of land before entering upon the large streams?

Mr. CARTEE. A good amount of land.

The CHAIRMAN. That is your experience?

Mr. CARTEE. Yes.

The CHAIRMAN. And in that light you think that the location of reservoirs and the lines of ditches would be undertaken by settlers before the large ditch would be constructed?

Mr. CARTEE. Yes.

The CHAIRMAN. Is that your knowledge, so far as the balance of the country is concerned?

Mr. CARTEE. Yes.

The CHAIRMAN. So that there would be important results from the surveys in the way of encouraging settlement?

Mr. CARTEE. Yes. Take Cañon Creek, which can not be forded in the spring. There is a lake there that would be 20 miles long.

The CHAIRMAN. Is there a large amount of land below it?

Mr. CARTEE. Yes, all the Rattlesnake country between here and what we call The Butte.

STATEMENT OF EPHRAIM SMITH, OF BOISÉ CITY.

Senator JONES (indicating a branch of a peach-tree in the display of fruit and vegetables that were gathered for the inspection of the committee). Have you measured that branch and counted the number of peaches on it?

Mr. SMITH. Yes.

Senator JONES. How many peaches are on it?

Mr. SMITH. The limb is 2 feet in length and it has on it twenty-nine peaches.

Senator JONES. This [exhibiting] is a peach off that limb?

Mr. SMITH. Yes.

Senator JONES. I find that it measures $8\frac{1}{2}$ inches one way and $8\frac{3}{4}$ the other way. Do you know the name of this peach?

Mr. SMITH. I do not.

Senator JONES. Do you know its quality?

Mr. SMITH. It is a freestone, yellow peach, the yellow freestone.

Senator JONES. You measured at my request the branch of a plum tree containing some plums.

Mr. SMITH. Yes.

Senator JONES. With what result?

Mr. SMITH. There are twenty-seven plums on the branch and the branch is 14 inches long.

Senator JONES. This [exhibiting] is one of the plums from off that branch?

Mr. SMITH. Yes.

Senator JONES. It measures 6 inches one way and 7 inches the other?

Mr. SMITH. That is right.

Senator JONES. Here is another plum of the same variety. That measures $7\frac{3}{4}$ inches one way and $7\frac{1}{4}$ the other.

Mr. SMITH. That is right.

Senator JONES. How many varieties of plums have you on exhibition here?

Mr. SMITH. I think there are something like thirteen varieties. That is what I and another gentleman made them out to be.

Senator JONES. Here is a blue plum. Measure that branch and state its length and the approximate sizes of the plums.

Mr. SMITH (after measuring). The branch is 11 inches long and has on it fifteen plums.

Senator JONES. And the plums are almost as large as these that have been measured?

Mr. SMITH. Yes.

Senator REAGAN. What is the name of that plum?

Mr. SMITH. That is the blue-gage plum.

Senator JONES (exhibiting). Here are some of the same kind. I do not know whether they came off that limb or not; but they are larger than any we have measured except one. This is $6\frac{1}{2}$ inches one way and $6\frac{1}{4}$ inches the other.

Mr. SMITH. Yes.

Senator JONES. This apple I have here is $15\frac{1}{2}$ inches one way and about 14 inches the other?

Mr. SMITH. Yes.

Senator REAGAN. What variety of apple is that?

Mr. SMITH. I do not know the name of that. General Cartee, do you know the name of this large apple?

General CARTEE. That is the Gloria Munda.

Senator JONES. I have here a pear that measures one way $11\frac{1}{2}$ inches and $10\frac{1}{2}$ the other. Then there are a large number of varieties of peaches equal in size, color, and flavor to those already described, and also a number of varieties of apples of various sizes and of beautiful appearance, which are not to be surpassed anywhere. I have measured another plum. What is the length of that branch from which this plum was taken [exhibiting]?

Mr. SMITH (after measuring). It is 1 foot in length.

Senator JONES. How many plums are on that branch?

Mr. SMITH. Sixty-three plums.

Senator JONES. And they are more than an inch long by an inch in diameter, I should say.

Mr. SMITH. Yes; the plum itself is.

Senator JONES. Of that variety one is 4 inches one way by 4 the other?

Mr. SMITH. I want to make a statement here in regard to some corn that I raised in the corporation limits. I raised some corn the stalk of which was 22 feet in length and had on it six ears, and the lowest ear was about 6 feet from the ground. The stalk we had to chop down with an ax. That corn was taken to the fair at New Orleans and it was a pride to look at it.

Senator REAGAN. Was that the Spanish seed?

Mr. SMITH. I got it from Illinois. It is the horse-tooth gourd-seed. That is what they sent it to me for. I raised a squash (a pumpkin) in my garden that weighed 85 pounds; but there was one brought up from Dixie Valley that weighed 118 pounds. The winesap, and other apples keep here sixteen months.

The CHAIRMAN. What is the difference between the land here without water and land with it—what transformation takes place?

Mr. SMITH. On land without water I have raised rye over half a crop. Some years I can raise a pretty good crop. I have been at it some time.

The CHAIRMAN. Can you raise other crops besides rye without irrigation?

Mr. SMITH. I do not know that we can. I have tested other crops

but have failed. But land that is cultivated and has plenty of water on it is worth from \$100 to \$125 down to \$30 and \$50, and so on.

The CHAIRMAN. How much land ought a farmer who works it himself have to support his wife and family, compared with farms in Illinois and other States?

Mr. SMITH. If a man has plenty of water he can support himself and family and make some money on 80 acres. A hundred acres would be abundant land for a large family. Our farmers here do not work their farms right; they let the brush grow up; they are cultivating brush and briars. We have a pretty good set of farmers, but I do not think they are up to the farmers of other countries.

The CHAIRMAN. Does a man need the same amount of land where it is irrigated that he would in a country where they do not irrigate?

Mr. SMITH. I think not, because on every inch of land you can grow something—wherever you put the water. You can grow vegetables where the roots go into the ground. I have seen them weighing from 40 to 50 pounds—a mangel-wurzel beet; carrots and parsnips grow here to an immense size, and the ruta-baga turnip would astonish you. I brought in some vegetables this morning that would astonish you, and it is right in the middle of the season.

Senator JONES. How do your potatoes compare with the potatoes grown in the East?

Mr. SMITH. It is said by the people from the East that we grow the best potatoes—better than anywhere else.

Senator JONES. Are you a practical fruit-grower?

Mr. SMITH. Well, I have been at it more or less.

Senator JONES. Is this exhibit which is here to-day a picked exhibit or is it a fair one?

Mr. SMITH. It is a fair example of what we can do. I have in my own neighborhood enough to show that it is not a picked exhibit. I had better peaches, but I did not bring them.

Senator JONES. I wish to ask you about your fruit crops.

Mr. SMITH. I have been here twenty-six years, and since I started—since the trees were three years old—I have always had enough for my own use and some to sell.

Senator JONES. How about your peach crop? Is it likely to be killed by frost?

Mr. SMITH. It never has been but once or twice since I have been here.

Senator JONES. Do you raise pears and apples easily?

Mr. SMITH. Yes, sir.

Senator JONES. Do these beautiful flowers which we see here grow in this neighborhood?

Mr. SMITH. Most of them grow in my garden, and I brought those you have before you. But they grow in all the private gardens here.

The CHAIRMAN. How does continuous cropping affect the land?

Mr. SMITH. I have been here some twenty-six years, and I have seen no difference. The farms grow as good crops as they ever did.

The CHAIRMAN. After continuous cropping?

Mr. SMITH. Yes; and there is a place called Poverty Valley, below here, and you can go by there and you will see nothing but fences for miles, and all the land in grain, and as much will be cut off that land this year as was ever cut before.

The CHAIRMAN. Do you think irrigation tends to fertilize the land?

Mr. SMITH. It is my experience that it keeps the land in order. By

irrigating it is almost like putting on dressing. The water coming from the mountains is filled with sediment that lodges on the ground.

The CHAIRMAN. Since this place was settled there has been no diminution in the crops?

Mr. SMITH. Not in consequence of the use of the ground.

STATEMENT OF T. A. STARRH, OF CASSIA COUNTY.

The CHAIRMAN. In what direction is Cassia County from here?

Mr. STARRH. South from here and about 60 miles east.

The CHAIRMAN. Is it on the waters flowing into the Snake River?

Mr. STARRH. Yes.

The CHAIRMAN. Is there any irrigation practiced in that county?

Mr. STARRH. Yes; we have between 35,000 and 40,000 acres now under irrigation.

The CHAIRMAN. With what success?

Mr. STARRH. Until this year with very good success.

The CHAIRMAN. This year there had been a deficiency of water.

Mr. STARRH. Yes.

The CHAIRMAN. How do the crops in Cassia County compare with those around Boise?

Mr. STARRH. Very good.

The CHAIRMAN. Can you raise all sorts of fruit and grain as are raised here?

Mr. STARRH. Yes.

The CHAIRMAN. How about cattle?

Mr. STARRH. It is very good in that direction.

The CHAIRMAN. Do you irrigate from the Snake River or its tributaries?

Mr. STARRH. Its tributaries.

The CHAIRMAN. From what streams do you irrigate?

Mr. STARRH. Rock Creek, Dry Creek, Goose Creek, Marsh Creek, Cache Creek, and Raft River.

The CHAIRMAN. Are these large or small streams?

Mr. STARRH. Raft River, during the season, will carry 45,000 inches of water.

The CHAIRMAN. How about Cache Creek?

Mr. STARRH. Twenty-five thousand inches.

The CHAIRMAN. And Marsh Creek?

Mr. STARRH. Marsh Creek will carry 15,000 inches of water.

The CHAIRMAN. Does any of this water run to waste in flood-time?

Mr. STARRH. It all runs to waste from December until about the 1st of May.

The CHAIRMAN. If the water were stored so that you had the whole of it in the proper season, would you be deficient in water there at any time?

Mr. STARRH. I think we could increase the acreage 60,000 acres if we had a way of storing the water, and each one would have more water than he has now.

The CHAIRMAN. Would surveys showing where reservoirs could be made with estimates of cost of construction be of any use in enabling the people to increase their water supply?

Mr. STARRH. I think so.

The CHAIRMAN. Would it open a chance for settlement?

Mr. STARRH. It would increase the present settlement.

The CHAIRMAN. You say there would be a chance for new farms if these things were known?

Mr. STARRH. Yes. It is higher land than the canals would meet.

The CHAIRMAN. There are places for storing water—ravines along the water-courses?

Mr. STARRH. Yes, we have some natural lakes.

The CHAIRMAN. They could be dammed or cut down?

Mr. STARRH. Yes, so as to increase the storage.

The CHAIRMAN. Or the outlet might be lowered?

Mr. STARRH. It would not be best to do that. They are the sources of other streams, and it would be better to dam them.

The CHAIRMAN. Are there any other facts in regard to your section that you would like to state?

Mr. STARRH. I would like to say that we have four or five thousand acres of land in our county that could be redeemed by a canal in addition to Snake River.

The CHAIRMAN. That is irrigated from the other streams of which you spoke?

Mr. STARRH. Yes.

The CHAIRMAN. And that might be increased 60,000 acres more by storage reservoirs?

Mr. STARRH. Yes.

The CHAIRMAN. And even more than that?

Mr. STARRH. Yes, that is a small estimate.

STATEMENT OF DELEGATE FRED T. DUBOIS, OF BOISÉ CITY.

The CHAIRMAN. As you have been frequently over the Territory, you may make a statement in regard to the arable land that it contains, what amount there is of it, and the facilities there are for irrigating it.

Mr. DUBOIS. I am not prepared to make a detailed statement, but I will say this in a general way, that I have traveled on horseback and in wagon over the entire Territory. I have been in every county and in almost all parts of every county, and my general observation is that there are fair streams in almost all sections, and there are immense plains, all reasonably level, and it is sage brush land. There is only one section of the Territory, that which is in the south center, which is covered with outcroppings of lava rock, and that seems to me to be entirely useless. Of course, I am not speaking as an engineer, but it would strike me, having been through Utah and countries which have been irrigated, that with a proper outlay, and not a very large outlay either, one-quarter of the Territory could be made productive, could be brought under cultivation.

The CHAIRMAN. How many acres are there in the Territory?

Mr. DUBOIS. Between 54,000,000 and 55,000,000 acres in the Territory.

The CHAIRMAN. And you estimate that one-fourth of that could be brought under cultivation?

Mr. DUBOIS. I estimate that between 12,000,000 and 15,000,000 acres of land in this Territory, taking it all together, could be brought under cultivation.

The CHAIRMAN. In passing over these mountains and the foot-hills and valleys, have you had your mind upon the question of whether or not small farmers could store water in the lakes and marshy places, the coulées and ravines?

Mr. DUBOIS. Not since I made a speech in Congress on the subject. Since then I have not traveled over the country much. But I have tried to refresh my mind since then. When I traveled over the Territory I did not have that in mind, but I can think of numerous places—some places at any rate.

Let me say, in passing, that there is one portion of the Territory which has not been touched upon at all, and yet I am not prepared myself to enter upon a discussion of it in detail. That is the southeastern portion, where Beaver Lake is. There, I should think, would be a good place for a natural reservoir where an immense lot of water could be stored without trouble. And I will say this, that most of our valleys are surrounded by mountains, and pretty high mountains, too, where snow falls. So that when you get your reservoirs in these valleys you can run the water down.

The CHAIRMAN. Suppose an accurate survey, showing the places for reservoirs, with estimates of the cost of construction, were made, what would be the effect of that before taking out the Snake River? Is there a section of country that could be taken up by settlers without much outlay?

Mr. DUBOIS. I think so. I think there are natural places which, with a small outlay, could be brought to such a condition that people could go in and without being dependent on immense canals and an immense outlay of money.

The CHAIRMAN. How would the lands on which they could go compare with the other lands in the valley?

Mr. DUBOIS. I should think they would be just as good as the main valleys. But I am not speaking as an expert.

STATEMENT OF JOSEPH C. RICH, OF BEAR LAKE COUNTY.

The CHAIRMAN. Are you a farmer?

Mr. RICH. No, I am not a farmer.

The CHAIRMAN. Have you observed the effects of irrigation down in Bear Lake County?

Mr. RICH. I have.

The CHAIRMAN. And have you observed to some extent the means they have there of obtaining water for that purpose?

Mr. RICH. Yes.

The CHAIRMAN. And the extent of country that might be irrigated?

Mr. RICH. Yes.

The CHAIRMAN. Give a description of that country, stating what has been done there, and what might be done.

Mr. RICH. Bear Lake County is, I believe, the smallest county in the Territory. The valley is 70 miles long, by from 5 to 10 miles wide. The southern part of the valley is occupied entirely by the lake, with the exception of a few small settlements, I think four, on the margin of the lake. About one-half of the lake is in Utah Territory, the north half being in Idaho.

The CHAIRMAN. Where does that lake discharge, in Utah or in Idaho?

Mr. RICH. In Idaho. The lake is about 8 miles long, and from 5 to 8 miles wide, and from 40 to 200 feet deep. It is filled with fish of the best quality.

The CHAIRMAN. Are there lands below it which could be irrigated?

Mr. RICH. The lands north of the lake and adjacent to it are very

nearly on the same level with the lake, although some of the lands that are now used, by the higher water rising in the mountains, could be watered by the lake, by damming the lake and increasing its volume.

The CHAIRMAN. Are there any valleys that would be benefited by an increase of the water in the streams?

Mr. RICH. Yes. Heretofore it has annually overflowed and made a good amount of hay land. But the lake for the last two or three years has been lower than it was ever known to be before, and the water in Bear River, which receives the water from the lake, has been taken out, and this season it has been entirely dry.

The CHAIRMAN. Was it dry in the flood season? If you had a dam would it have saved any water for this season?

Mr. RICH. It would have held it in the lake.

The CHAIRMAN. Has the water run out in flood season to any considerable extent?

Mr. RICH. Yes. It could be increased in depth and could be controlled. The outlet is only about 40 feet wide.

The CHAIRMAN. What kind of crops do you raise in that valley?

Mr. RICH. That valley is high; the elevation is 6,000 feet.

The CHAIRMAN. And you raise what kind of crops there?

Mr. RICH. Small grain; wheat, oats, barley, some rye, and all kinds of hardy vegetables, and grass and hay.

The CHAIRMAN. Is there much ground that could be brought under irrigation in your county?

Mr. RICH. Yes; by a system of reservoirs outside of the lake there might be probably about 40,000 acres additional brought under cultivation in that county.

The CHAIRMAN. Could that be obtained by a combination of citizens and without great expense?

Mr. RICH. I think it is rather too much for the citizens. We need some help. I will state that heretofore, until the last two or three years, Bear River has been full. But as I stated, this season it has dried up in places. For a month or two there has been no water in it. Water has been taken out above. There are some fifteen or twenty dams in Wyoming. The water can be run into the river from Bear Lake, but on this side there is what is called the rim of the Salt Lake basin, and the waters of Bear Lake will never rise high enough to bring it over that rim. There is land in Gentile Valley and Bear River Valley that can be watered by that lake.

The CHAIRMAN. They need it in Utah.

Mr. RICH. Yes.

The CHAIRMAN. It runs down through Cache Valley?

Mr. RICH. Yes.

The CHAIRMAN. And by storing the water it would help them down there, would it not?

Mr. RICH. Yes.

STATEMENT OF E. S. WHITTIER, OF SODA SPRINGS, BINGHAM COUNTY.

The CHAIRMAN. Is irrigation practiced in Bingham County?

Mr. WHITTIER. Yes; I own a large extent of land on Snake River, of which you have been told. But the eastern part the surveyor's report does not touch. I live in Bear River Valley, which is distinct from Snake River Valley.

The CHAIRMAN. Is that to be watered by the Snake River?

Mr. WHITTIER. No; it runs into Salt Lake.

The CHAIRMAN. What are the opportunities for irrigating your valley?

Mr. WHITTIER. They come from Bear Lake, the same lake of which Mr. Rich has been speaking.

The CHAIRMAN. Do you concur in his opinion, that that could be improved by making the lake a reservoir?

Mr. WHITTIER. My residence is some 60 miles down, in the neighborhood of Gentile Valley.

The CHAIRMAN. Have you plenty of water there?

Mr. WHITTIER. No.

The CHAIRMAN. Is there sufficient to bring the land under cultivation?

Mr. WHITTIER. There is if there were reservoirs at the lake.

The CHAIRMAN. Would it be expensive to make reservoirs at the lake?

Mr. WHITTIER. Not there; and it could be easily controlled.

The CHAIRMAN. Have they been troubled in Cache Valley, down below you, in Utah?

Mr. WHITTIER. I have been told so; but I have not been down there.

The CHAIRMAN. The water that passes you was not as much as usual this year.

Mr. WHITTIER. The water has dried up to such an extent that it has not run in the river. Parties down there having a canal enterprise on hand have been up trying to locate our lakes, saying that they were short of water.

The CHAIRMAN. You raise all the hardy vegetables in your section?

Mr. WHITTIER. I am in the general merchandise business, but I handle vegetables. We ship potatoes, fruits, and vegetables, and all kinds of grain, all over the country. The land is not good except for small fruits, but grain we raise well. We had at the agricultural fair one squash that weighed 112 pounds; and the fruits and vegetables grow proportionately large.

The CHAIRMAN. And you say small grain does first class?

Mr. WHITTIER. Yes.

The CHAIRMAN. How much is a fair crop of wheat?

Mr. WHITTIER. 36 to 40 bushels.

The CHAIRMAN. And of barley?

Mr. WHITTIER. They raise about the same as wheat. They raise from 50 to 70 bushels of oats. I would like to make a statement in regard to a certain body of land that is right close to Soda Springs, containing about three and a half townships. That has been surveyed, and the ditches have been surveyed out on to it. But the expense is a little too much for our people there. There is a body of land, about eight townships, above there favorable for irrigation, and the water, I believe, could be put on to it for \$100,000; that is, according to surveys made by private parties. That land covers about eleven and a half townships.

The CHAIRMAN. That would be 253,000 acres, and it could be irrigated for how much?

Mr. WHITTIER. From the surveys that have been made it could be done for \$100,000.

The CHAIRMAN. What would the land be worth when irrigated?

Mr. WHITTIER. It is a distance from market; but every foot of it would be worth \$10 an acre, and a good deal of it more. The climate there is not as severe as it is north and east.

The CHAIRMAN. How much alfalfa could you raise on that land?

Mr. WHITTIER. Five to seven tons, and we could raise wheat and everything of that kind. It has a high elevation.

The CHAIRMAN. Is it a good stock country.

Mr. WHITTIER. Yes. The average fall of snow is never over about 8 inches.

The CHAIRMAN. What experience have you as to the effect of cutting timber on the streams?

Mr. WHITTIER. I have been district attorney for that county, and there have been 250,000 to 300,000 acres of timber burned off in that county, and I have been unable to fasten it on to anybody. We have had more timber burned off than was cut in the last twenty years.

The CHAIRMAN. Have you any suggestion to make to the Government of a policy that it could pursue, and that would tend to save the forests. If the forests should be destroyed that would be a drawback to irrigation, because they keep the snow back.

Mr. WHITTIER. The General Land Office has been assisting me, and it has been attending to that business. But the laws seem to be deficient.

The CHAIRMAN. Instead of having special agents, suppose you had local timber agents with an office in their respective localities to look after the timber. Suppose with these local agents the Government should withdraw all the timber from the market and grant permits to anybody who might wish to cut the timber and clear away the brush; do you think anything could be done in that way?

Mr. WHITTIER. It would be an advantage in the eastern and northern parts of our county. We have large bodies of timber there.

The CHAIRMAN. Do the communities get prejudiced against these special agents, or do they vary?

Mr. WHITTIER. They vary. But the special permission to cut timber would do very well.

The CHAIRMAN. Do you think the people would co-operate if you had an officer in each district to watch over the timber?

Mr. WHITTIER. I think so, provided it were not arbitrary. If the agents would co-operate with the people in respect to cutting the timber, I think they would co-operate with him, and it would do much to save timber from destruction.

The CHAIRMAN. How does the amount of timber which is cut compare with that which is burned?

Mr. WHITTIER. There has not been as much cut off in our county for twenty years as there has been burned.

STATEMENT OF JAMES HAWLEY, OF BOISE CITY,

The CHAIRMAN. You have heard the testimony on the subject of forest fires, and you can give us your experience in that direction.

Mr. HAWLEY. I will say in regard to forest fires that they have been in certain years very destructive, especially dry seasons, such as the the present. These fires are caused by parties setting out fires in the mountains, for camping purposes, without taking care that they do not set fire to the dry timber and underbrush, and it is almost impossible to prevent them. So far as the destruction of timber is concerned, I agree with Mr. Whittier. I am familiar with all parts of Idaho, and I can say that there has been more timber destroyed by fire during the last twenty years than was cut. That is, in the timber sections of the Territory. My idea would be that the Government should take some

measures to make an appropriation in the Territories for the purpose of preserving the timber, either do it by special agent, or I think it would be better to put the appropriation in the hands of the Interior Department, subject to the orders of the governor, to be called into play in a proper way by a board of commissioners. There are very few of these fires, and if they were taken at the start, they could be kept from spreading over any extent of country. For instance, if the county had the right to call on the governor for a certain amount of money, it would be easy to start a fire into a fire and thus prevent its spread.

The CHAIRMAN. Would it not be better to have a Government officer in a reasonably sized district whose duty it would be to attend to the matter?

Mr. HAWLEY. If you could get a Government officer who belonged in the Territory and understood the wants, that would be a good thing. But the Governor of the Territory is better conversant with it than the agents would be.

The CHAIRMAN. How would it be to substitute a local officer, a man who lived in the district? Would not that be more effective than the present system, where a stranger is called upon to watch?

Mr. HAWLEY. I think much more effective.

The CHAIRMAN. Is there a prejudice against strangers being brought into the Territory for that purpose?

Mr. HAWLEY. There has been considerable prejudice in the Territory against these special agents.

The CHAIRMAN. Would or not the people co-operate if one of their own citizens were appointed an officer to look after the timber, with power to grant permission to cut it?

Mr. HAWLEY. I think they would co-operate with any one appointed from their midst; but so far as permission is concerned, I do not think it is necessary.

The CHAIRMAN. In the mining regions they can cut timber for certain purposes; but the question is what is the purpose?

Mr. HAWLEY. Yes. The United States attorney for the last four years until the last two years had occasion to settle the laws in the courts—everything affecting timber.

The CHAIRMAN. Would you advise the withdrawal from sale of timber land not fit for agriculture?

Mr. HAWLEY. No; I would advise their withdrawal from sale in certain places, and in other localities open them to sale, allowing the parties to acquire title. I would allow certain portions to be purchased. I notice in my experience that where you denude a hill by a stream the stream decreases in volume.

The CHAIRMAN. It decreases in summer time.

Mr. HAWLEY. It goes with the flood. There is nothing to keep the snow back, and it goes down the valley.

The CHAIRMAN. With regard to the subject of irrigation, have you given any thought to that?

Mr. HAWLEY. I have given considerable thought to the matter.

The CHAIRMAN. To what extent could this country be irrigated?

Mr. HAWLEY. I would rather not address myself to figures; but I think the figures given by other gentlemen are correct. I think that between a third and a fourth of the land of the Territory could be irrigated.

The CHAIRMAN. The Government has commenced the work of making surveys for the purpose of ascertaining what amount of land can be irrigated and what can not be, designating reservoir sites, and estimat-

ing the cost of constructing hydraulic works, etc. We have had a pretty good general statement with regard to handling the larger streams, rivers, and creeks. Now, is it or not a fact that if these surveys were made they would show a large extent of country that could be entered upon immediately?

Mr. HAWLEY. There is a large section of country in the aggregate that could with a comparatively small expense be irrigated. Take the Lost River Valley. A reservoir system in that valley to hold back the water that otherwise goes to waste—and it could be done at a small expense—would be the means of reclaiming from twenty to one hundred thousand acres of land.

The CHAIRMAN. Are there places where a thousand or two or three hundred acres of land could be reclaimed from small streams?

Mr. HAWLEY. Yes; there are places of that kind. But take an enterprise like that of the Lost River. There is a section of country that has not been mentioned. It is in Custer County. It will average in arable land 5 miles in width. The Lost River sinks in a lava bed; but at the head there is a large body of water, and there are places where it could be collected in a reservoir to irrigate all that country. There they could raise vegetables and everything of that kind. But the men who desire to go in and make settlements are poor men, and although the expense seems small compared with the amount of land that could be irrigated, yet they are unable to enter upon the work.

The CHAIRMAN. Is it generally too expensive for them to obtain the information and make the preliminary surveys?

Mr. HAWLEY. It would be to make preliminary surveys, unless the Territory did it or the General Government. You could not depend upon those settlers doing that.

The CHAIRMAN. The settlers do not know what can be done, and they have no money to hire surveyors?

Mr. HAWLEY. No; when they see water running in a stream they know how to turn it on to their land; but when it comes to storing water for future use, that is another matter.

The CHAIRMAN. They are not competent to consider that?

Mr. HAWLEY. No.

The CHAIRMAN. So that you think surveys to determine those matters for them would encourage settlement?

Mr. HAWLEY. I think so.

The CHAIRMAN. Independently of the larger enterprises of taking out the great rivers?

Mr. HAWLEY. Yes; the great rivers like Henry Lake will make a reservoir that will cover a large amount of land that would be on the North Fork. I have an idea of irrigation that I would like to give to the committee. We would like to see the General Government take hold, and, if possible, construct our reservoirs and canals and sell the land with the water rights. But whether or not it is possible to carry on such a system of irrigation, as I understand it, is in doubt. But whatever aid the General Government can give, well and good. If they could not utilize all this water or find that the expense is too great, I would suggest to the committee that it might be wise for Congress to treat the arid lands of this country in the same manner that they did the swamp and overflowed lands. In other words, if they would give these arid lands to the State, and let the State work out its own salvation, it would be wise. But if Congress is unwilling to do that, instead of going on and making appropriations of a small amount of money and having the work of reclaiming this land delayed for many years, let it

give to the State the right under proper regulations to put water on to the land and sell the land to actual settlers.

STATEMENT OF ALECK DANSTIN, OF BLACKFOOT.

The CHAIRMAN. Are there any artesian wells in your vicinity?

Mr. DANSTIN. There are right close by, a little south of Blackfoot, in the southern part of the county. I have never seen them.

The CHAIRMAN. Do you know how much water they flow?

Mr. DANSTIN. I am told it is a pretty large flow.

The CHAIRMAN. Do you know what depth they went in boring the well?

Mr. DANSTIN. No.

The CHAIRMAN. Do you know anything about the stratification through which they went?

Mr. DANSTIN. No.

The CHAIRMAN. Are they using the wells for farming purposes?

Mr. DANSTIN. In a small way; not a large piece.

STATEMENT OF C. J. BASSETT.

The CHAIRMAN. Have you any information which you desire to give with regard to artesian wells in Bingham County?

Mr. BASSETT. I have seen the artesian wells of which Mr. Danstin spoke, at Oxford, Bingham County.

The CHAIRMAN. What is the extent of the wells?

Mr. BASSETT. Mr. Harkness has on his land four, and has the water running over about 20 acres of land. There is about 20 inches per second of flow, and he irrigates 20 acres of land. He sunk the wells for the purpose of watering his stock, he having a large stock ranch there.

The CHAIRMAN. To what depth did he go for water?

Mr. BASSETT. Only about 80 feet.

The CHAIRMAN. They flow out to the surface?

Mr. BASSETT. Yes; they went through dry land; some clay and sand and gravel.

FURTHER STATEMENT OF T. A. STARRH.

Mr. STARRH. The leading people of Cassia County have for a long time recognized the necessity of reservoirs. They would be of great use to the entire community. The few who were able, however, to put up money to make surveys did not feel that it was their duty to do so for the general public. The county is a pretty fair sized county and the different locations cover a number of places. In fact the head of each stream has places where reservoirs could be built and some of them two or three locations along the stream. The general business of the country has been at a stand-still on account of the water question. Even if a large canal were made down Snake River, after it was commenced it would take some three or four years to complete.

The CHAIRMAN. You recognize the right, if you store water and turn it into a stream, to take out an amount below?

Mr. STARRH. That seems to be the opinion of the people in our country. In fact we have two reservoirs in our county, but each one

of them was made by individuals and they recognize that right—the right to draw as much from the reservoirs as they thought they had stored.

The CHAIRMAN. There will probably have to be some sort of local government about it.

Mr. STARRH. I think so; but it will be a nice question to settle, for I don't think it is a question that you can leave to every one to settle for himself.

The CHAIRMAN. You would have to have some form of local government about it. For example, you would need to have a water master to divide the water up among the people in proper proportions and at the proper time so as to secure an economy in the use of the water.

Mr. STARRH. Yes. Of course we have not enough water in our county to enable us to irrigate all our land. But no railroad company has had sufficient inducement to come in there to cheapen transportation, and that has been a great disadvantage.

The CHAIRMAN. What scheme for a railroad has been projected there?

Mr. STARRH. There was one that was projected from Salt Lake City by some eastern firm I believe in connection with a Montana firm. There was an original survey made by the Union Pacific Railroad Company across Snake River somewhere near the Park; also the Denver and Rio Grande Railroad intended coming through there, but was prevented by some money troubles.

STATEMENT OF J. C. FOX, OF CUSTER COUNTY.

The CHAIRMAN. What is your occupation?

Mr. FOX. I have been in a saw-mill. I am now in a mining company.

The CHAIRMAN. In what part of the Territory is Custer County?

Mr. FOX. A little over 100 miles northeast from here.

The CHAIRMAN. Is it on the water-shed of Snake River?

Mr. FOX. No; on that of the Salmon River.

The CHAIRMAN. Is irrigation required in that county?

Mr. FOX. Altogether.

The CHAIRMAN. Will you state how that county is situated; about how much land and how much water it has?

Mr. FOX. Custer County is a new county. It has but very little irrigation, and, comparatively speaking, not a great deal of farming is done compared with older counties; not, for instance, compared with this county. About probably one-fourth of the county is capable of growing all agricultural products that are raised here.

The CHAIRMAN. About what area of land would that be; about how many acres?

Mr. FOX. I should think there are probably 40 or 50 miles in length by perhaps 5 miles wide. There is not water enough there to irrigate all that land unless it is reservoired. Of course there could be reservoirs made there, but to irrigate the whole of it would be expensive. I do not know whether there would be water enough to irrigate the whole of it even if it were stored. There is water enough of course if it could be all retained, but it could not be. The Salmon River is quite a large stream and affords all the water probably that is necessary to irrigate both Custer and Lemhi Counties. It runs through both of them and enters into the Snake River at Lewiston.

The CHAIRMAN. Is there much land that can be cultivated in Lemhi?

Mr. FOX. Yes, a great deal. I am not so familiar with it as Governor Shoup. Probably he can state it better than I can. Perhaps the report however covers it.

The CHAIRMAN. I think the report is pretty full on each county.

Mr. FOX. It is not very full on our county. There is probably seven or eight times more land there that can be cultivated than our report speaks of. The gentleman who made the report is well qualified to make it but has not traveled over the county very much, and did not know how much there was. There are 50,000 or 60,000 acres of land there that would make good arable land. We are somewhat higher there than this place. Corn is not raised there to any extent. They sow nothing there except what grows quickly. The greatest portion of our county is mountainous, and the principal products there are silver and lead.

The CHAIRMAN. You raise good crops there when you do irrigate, do you?

Mr. FOX. Excellent.

The CHAIRMAN. The same kinds that are raised here?

Mr. FOX. Yes.

The CHAIRMAN. Is the soil good?

Mr. FOX. The soil is very good. Probably the soil is quite as good as the soil here. I think they use the same crop and the same ground for three or four or five years. After that I think it would not raise as good a crop as it would have formerly.

The CHAIRMAN. Have you seen that tried?

Mr. FOX. Yes; I have a ranch there and have raised 50 or 60 bushels to the acre of oats. It has been in oats for four or five years now, and it does not raise quite so much to the acre as when we first took it up. Of 120 acres, 20 acres of it was wheat, and it averaged 60 bushels to the acre all around.

Senator JONES. Was that on the first crop?

Mr. FOX. Yes.

Senator JONES. Have you produced other wheat crops afterward from it?

Mr. FOX. Yes; this was an average of wheat and oats together. The wheat of course was not as good as the oats. The wheat was 38 bushels, I think, the first year, and the oats were over 60. The frost came the first year about the 20th of August. We had not got the water on the crop early enough, and so it did not get quite ripe.

Senator JONES. What have you made in wheat the other years?

Mr. FOX. About 40 bushels.

Senator JONES. There is no decrease in the crop, then, since the first year?

Mr. FOX. Not generally. They do not generally sow wheat so much in succession to itself as they do oats. I want to state here that not an acre of land in Custer County has been surveyed, and many are holding more land there than they would hold if it were surveyed.

The CHAIRMAN. Do you think a survey which would direct the settlers where to find water, etc., would be of use?

Mr. FOX. Yes; it certainly would be of great benefit. But unless the land is surveyed so that it can be taken up in smaller quantities, men will hardly know what is there. Of course, at present the right is but a squatter's right, but some have taken up land under the desert-land act.

STATEMENT OF FRANK RIBLETT, OF ALBION.

The CHAIRMAN. In what part of the Territory do you reside?

Mr. RIBLETT. The south-central part; Cassia County.

The CHAIRMAN. Near the Nevada line?

Mr. RIBLETT. Yes; Nevada and Utah bound us on the south.

The CHAIRMAN. What is your occupation?

Mr. RIBLETT. I am a civil engineer.

The CHAIRMAN. Have you been engaged in the business of surveying lands and water-ditches in your county?

Mr. RIBLETT. Yes.

The CHAIRMAN. For how long?

Mr. RIBLETT. A little over ten years.

The CHAIRMAN. Will you describe the character of the country in Cassia County?

Mr. RIBLETT. We have a very large area of valley lands. The principal valleys are those of the Raft River, the Goose Creek, and the Salmon River.

The CHAIRMAN. Then you have a Salmon River there?

Mr. RIBLETT. It is called sometimes Salmon River and sometimes Salmon Creek. It enters into the neighborhood of the Salmon Falls.

The CHAIRMAN. Do any of those streams rise over in Nevada or Utah?

Mr. RIBLETT. Yes, some of the heads of them are in Nevada and some in Utah.

The CHAIRMAN. Is there much average land in your county?

Mr. RIBLETT. I should judge that in these large valleys there would be found over a million acres in that county, and probably 500,000 acres more on the higher lands.

The CHAIRMAN. How much of it can be irrigated?

Mr. RIBLETT. At least 1,000,000 acres.

The CHAIRMAN. Explain how you would irrigate a million acres there.

Mr. RIBLETT. The flood volume of the streams of Cassia County would furnish water, if properly reservoired, for the irrigation of probably 500,000 acres. A canal from Snake River would cover 700,000 acres, and 200,000 acres covering these reservoirs would be under the horizon of the canal from Snake River.

The CHAIRMAN. To what extent could settlers go upon it and by uniting bring in their own ditches, providing the surveys were made to give them information?

Mr. RIBLETT. I think only to a very limited extent. They would have to have assistance either from capital or from some other source.

The CHAIRMAN. Are the enterprises already there expensive, or are they some cheap enterprises?

Mr. RIBLETT. They are cheap compared with the land they would cover, but of great magnitude after all.

The CHAIRMAN. You mean they are cheap per acre?

Mr. RIBLETT. Yes; they are cheap per acre.

The CHAIRMAN. Have you ever estimated how much it would cost to irrigate the million acres you spoke of?

Mr. RIBLETT. I should judge \$5,000,000.

The CHAIRMAN. How much would it be worth after it was irrigated?

Mr. RIBLETT. About \$30 an acre.

The CHAIRMAN. Is it good land?

Mr. RIBLETT. The best of land.

The CHAIRMAN. Does it raise fruit also?

Mr. RIBLETT. Yes; I have seen some fine peaches raised in that county. All the hardy fruits can be raised in that county.

The CHAIRMAN. How is it in the southern part, where Utah and Nevada join?

Mr. RIBLETT. It is more mountainous there.

The CHAIRMAN. Have you been much into Utah and Nevada opposite Cassia County?

Mr. RIBLETT. Yes.

The CHAIRMAN. What kind of country have they there?

Mr. RIBLETT. I have never been in the valleys much, but I have been in the mountains on the borders of Cassia County.

The CHAIRMAN. Are the mountains high there?

Mr. RIBLETT. They vary. Some of the streams are on the low tablelands and some are in the mountains. Goose Creek, for instance, has a very extensive water-shed of about 1,000 square miles.

The CHAIRMAN. Is that in Nevada?

Mr. RIBLETT. Partially in Nevada and partially in Utah. The depth of snow on this water-shed is estimated by trappers, hunters, and stock men at from 3 to 4 feet.

The CHAIRMAN. I have heard of a white sage-brush plain in that region where people winter stock. Is that in your county?

Mr. RIBLETT. We have several sage plains.

The CHAIRMAN. The one I refer to is that to which a good deal of stock has been sent from Elko, and further I was told it was in Idaho or Utah.

Mr. RIBLETT. I do not know of any.

The CHAIRMAN. Does it destroy sage-brush to feed it off?

Mr. RIBLETT. It has done so in our county. Sheep will destroy it.

The CHAIRMAN. This enterprise involving \$5,000,000 is not all one enterprise, I presume, but would involve a good many enterprises?

Mr. RIBLETT. I am speaking of a grand system of reservoirs and canals taking in the volume of the small streams, and a canal from Snake River.

The CHAIRMAN. Could you divide it up so as to let us see what would be the least expensive scheme?

Mr. RIBLETT. Some would cost only \$2 or \$3 an acre.

The CHAIRMAN. How much would it cost in the aggregate for some of your easy schemes?

Mr. RIBLETT. I will mention one—Goose Creek. There is a basin there that is 900 acres in extent; that can be covered with about 100 feet of water by a dam 100 feet wide at the bottom and 200 feet at the top and 140 feet high.

The CHAIRMAN. What would be the expense of that?

Mr. RIBLETT. Not to exceed \$100,000.

The CHAIRMAN. How much land would it cover?

Mr. RIBLETT. At least 40,000 acres.

The CHAIRMAN. That would be about \$2.50 an acre.

Mr. RIBLETT. Yes.

The CHAIRMAN. Is the land in your county mostly public land?

Mr. RIBLETT. Yes.

The CHAIRMAN. There are no railroad grants in it, are there?

Mr. RIBLETT. I think there is a very little in the southeast corner—Central Pacific lands.

The CHAIRMAN. You may state to the committee any other facts that occur to you, that will be useful in their inquiry.

Mr. RIBLETT. I might say that the flood volume of Cassia County would not be less than four or five thousand million cubic feet, if properly stored. I am not stating these figures at random. I have been a witness in water suits, and have had occasion to measure this sort of thing.

The CHAIRMAN. Have you heard of any efforts, by suits, to measure water, to see whether the parties had enough?

Mr. RIBLETT. Not yet. The matter to some extent may be litigated at the next term of court.

The CHAIRMAN. Colorado passed a law requiring the district attorney to bring suits on each stream and make all parties parties to the record who claim water, so as to make them prove up the date of location and the quantity appropriated. Then a schedule was made and those making new appropriations were required to make a record of it, and then a water-master was appointed to distribute it according to priority. You have not yet anything of that kind in Idaho, have you?

Mr. RIBLETT. No. I would like to say that for about nine years an association of citizens of Cassia and Logan Counties has been investigating the project of turning the waters of Snake River at Storey's Ferry for the irrigation of lands in Logan and Cassia counties. This scheme, if carried out, will irrigate at least 85,000 acres in Logan County and 15,000 acres in Cassia County. The 85,000 acres in Logan County are unsurveyed, and in order to procure capital in furtherance of this project and for the benefit of Logan County, it would be necessary for this land to be surveyed by the Government, and in connection with other lands, in case it can be found that the canals can be extended farther, to see if more land can not be covered in both counties.

The CHAIRMAN. I presume if the Government goes on with this policy of ascertaining what lands can be irrigated and what not, it will have the irrigable lands all surveyed. The settlers can not do that very well.

Mr. RIBLETT. There are a great many other lands in Cassia County which should be surveyed. The appropriations seem to have been insufficient. In regard to the exhaustion of Snake River, it has been shown practically in the experience of Cassia County that water can be used for irrigation and it will rise again farther down the stream by percolation, and can be so used several times in succession. I do not think that if the entire water of the Snake River were turned into Bingham County it would make any difference in the volume in Cassia County.

The CHAIRMAN. If there was not, the storage system would make it all right, at any rate, would it not?

Mr. RIBLETT. Yes; because I think that during high water there are not less than 50,000 second-feet in Snake River. We measured it on the 22d of July at Storey's Ferry; as near as we could estimate it there were about 5,500 second-feet at extreme low water. The river is lower than it has been for twenty-five years, and was at least 14 feet below ordinary high-water mark and nearly 17 feet below the maximum high-water mark. So there would probably be at least 50,000 second-feet. In regard to the arable land of Cassia County at least one-half ranges from 4,000 to 4,500 feet. Some will be more and some less. To more fully show the character of Goose Creek Valley I will state, and without, I think, danger of contradiction, that at least 160,000 acres in the valley can be selected in which there would not be 160 acres of waste land.

The CHAIRMAN. The land is fertile?

Mr. RIBLETT. Extremely so. Let me make one other statement. I was in a field of volunteer wheat, wheat that ran over from the previous year, wheat that sowed itself so to speak; of that there were about 8 acres, and that will average when it is thrashed at least 100 bushels to the acre, as estimated by careful farmers. The field has been cropped for six or eight years.

The CHAIRMAN. Does it produce good crops every year?

Mr. RIBLETT. I will not say that that is an average, but it shows what is done sometimes.

The CHAIRMAN. The land is irrigated, is it?

Mr. RIBLETT. Yes.

STATEMENT OF JOSEPH A. CLARK, OF EAGLE ROCK.

The CHAIRMAN. Eagle Rock is on the Snake River?

Mr. CLARK. Yes.

The CHAIRMAN. Have you given any attention to irrigation?

Mr. CLARK. Yes.

The CHAIRMAN. Have you been engaged as an engineer in making surveys for irrigation?

Mr. CLARK. Yes.

The CHAIRMAN. What do you say as to the facilities for irrigation and what as to the land needing irrigation in your county?

Mr. CLARK. The facilities are first class and the land is also first class.

The CHAIRMAN. How much land have you in your county that is susceptible of irrigation?

Mr. CLARK. I understand it is reported here to-day as something over 2,000,000 acres. I am not so well acquainted with the county as with my own neighborhood.

The CHAIRMAN. In the neighborhood of Eagle Rock how much land is there that can be irrigated by one system?

Mr. CLARK. We have now about five townships under one irrigating system.

The CHAIRMAN. That is a little over 100,000 acres?

Mr. CLARK. Yes.

The CHAIRMAN. What stream do you irrigate from?

Mr. CLARK. From Snake River.

The CHAIRMAN. What will be the expense per acre to irrigate five townships?

Mr. CLARK. We estimate it from \$3 to \$5, but that is probably a little over the real cost.

The CHAIRMAN. It will cost then some \$300,000 or \$400,000 to construct the ditch?

Mr. CLARK. Yes; to irrigate that land.

The CHAIRMAN. What would be your plan? Would you ditch from Snake River?

Mr. CLARK. We have head-gates directly in the river, and take the water out in canals that are about 30 feet wide at the bottom.

The CHAIRMAN. You do not find it necessary to build any dams in the river. You put your head-gates in and take it out at the level of the flow?

Mr. CLARK. This is the first year we have had to do that. Heretofore the water has been sufficient to take it out without a dam.

The CHAIRMAN. You have had to dam it this year?

Mr. CLARK. Yes.

The CHAIRMAN. Is there a rock bottom, so that you have no difficulty in making dams?

Mr. CLARK. We make them without much trouble, but the probability is that if these dry years continue very long, it will be necessary to make permanent dams, unless we go higher up or lower our works.

The CHAIRMAN. Is it productive land—the land in these five townships.

Mr. CLARK. Yes.

The CHAIRMAN. What is its character?

Mr. CLARK. It is clay loam, sandy somewhat, and bears sage-brush.

The CHAIRMAN. Is it strong land?

Mr. CLARK. Strong land? Yes.

The CHAIRMAN. Is there basaltic or lava rock below?

Mr. CLARK. A portion of it is lava, so that we can not get good wells. Then another portion of it is not, and there we get very good water.

The CHAIRMAN. How do you find the soil? Do you find it equally irrigable where the lava rock is near the surface?

Mr. CLARK. I think so.

The CHAIRMAN. The water wastes on account of its fractured condition, does it?

Mr. CLARK. Yes.

The CHAIRMAN. Is it fractured very much, so that the water percolates down through it?

Mr. CLARK. I do not think there is a great deal of loss in that way.

The CHAIRMAN. You have heard the testimony here. State any facts that you wish the committee to know.

Mr. CLARK. I have been an interested listener. I think it likely that we shall have to have reservoirs on the river in order to keep the supply. The canals under construction, if they were all fixed up at present, would take pretty nearly all of the water out of the river, and it would be consumed in that valley and farther down. I think it likely in an ordinary year the canals now constructed would exhaust Snake River through the ordinary irrigating season, but if reservoirs could be made on the upper waters that difficulty would be avoided.

The CHAIRMAN. Are you familiar with the headwaters?

Mr. CLARK. I have been 50 or 60 miles above the head-gate. I have not been to the lake spoken of, but I am satisfied that the opportunities for storage are there.

The CHAIRMAN. Can you tell us anything more in regard to your country?

Mr. CLARK. No; I think not. It is a new country, and we have no fruit-bearing trees there yet. I think it is about 1,500 feet higher, perhaps, than this place. But the smallest trees are not yet a success.

The CHAIRMAN. As far as vegetables are concerned, are they a success?

Mr. CLARK. Yes; our county fairs have been a great success, and the vegetables there are very good.

The CHAIRMAN. Are there many places where the settlers could irrigate by themselves by a combination of a few farmers?

Mr. CLARK. That is the irrigation that is being done mainly in our Territory. There is no foreign capital doing it.

The CHAIRMAN. There is no water taken out to be sold?

Mr. CLARK. No. Opportunities are offered for a ranchman to go and take as much water as his land will need.

The CHAIRMAN. Do you say you are irrigating now 100,000 acres there?

Mr. CLARK. There are 100,000 acres under the canal, but it has not all produced yet.

The CHAIRMAN. You mean the water is so arranged that it can be put on all that acreage?

Mr. CLARK. Yes, and counting a miner's inch for two acres the company is stocked for about 40,000 acres, but we are enlarging these canals every year, and expect to reach 100,000 acres.

The CHAIRMAN. But you have not got water yet for 100,000?

Mr. CLARK. No. There are close on to 40,000 in cultivation in that valley.

The CHAIRMAN. They are using, then, about all the water that the ditch will afford?

Mr. CLARK. Yes.

The CHAIRMAN. How much per acre has it cost to construct these works up to this time?

Mr. CLARK. It has cost altogether about \$100,000.

The CHAIRMAN. That will be about \$2.50 an acre?

Mr. CLARK. Yes.

The CHAIRMAN. Does that mean the main ditches alone, or does it include the side ditches?

Mr. CLARK. The main ditches.

STATEMENT OF E. C. HELFRICH, OF LAMAR COUNTY.

The CHAIRMAN. What is your occupation?

Mr. HELFRICH. General merchandise.

The CHAIRMAN. On the water-shed of the Snake River?

Mr. HELFRICH. Yes.

The CHAIRMAN. What rivers have you running through it?

Mr. HELFRICH. The Snake River and the South Bois . Water is taken from the South Bois .

The CHAIRMAN. Has there been any water taken out from the Snake River?

Mr. HELFRICH. No.

The CHAIRMAN. Is there any irrigation in the county?

Mr. HELFRICH. There is not an irrigating ditch in the county.

The CHAIRMAN. What do the people do?

Mr. HELFRICH. Up to this season they have depended upon the little creeks that come in the little breaks of the mountains. They are all hay ranchers. There is not a farmer among them. No farming is done there.

The CHAIRMAN. Do the sheep or cattle men own the lands?

Mr. HELFRICH. No; it is public land.

The CHAIRMAN. Is it well adapted for farming?

Mr. HELFRICH. Yes.

The CHAIRMAN. Could water be got on the land by reservoirs?

Mr. HELFRICH. To a limited extent.

The CHAIRMAN. If that could be done it would make some good farms, would it not?

Mr. HELFRICH. Yes.

The CHAIRMAN. That would be higher up, or around the foot-hills, I suppose?

Mr. HELFRICH. Yes.

The CHAIRMAN. As to the rest, how is it?

Mr. HELFRICH. There would not be enough coming from the Snake

River to cover the tributaries to it. The South Bois  drains away the whole mountain system, and the creeks are just this side of South Bois  River, so that they have to take the leavings.

The CHAIRMAN. What amount of arable land have you in the county?

Mr. HELFRICH. About 220,000 acres.

The CHAIRMAN. Have you ever had an estimate made as to what it would cost to bring water on it?

Mr. HELFRICH. We made an estimate for a storage reservoir two years ago. That was supposed to cost about \$6,000.

The CHAIRMAN. That would be a good enterprise, would it not, for the farmers?

Mr. HELFRICH. Yes; but it would be of no use this season.

The CHAIRMAN. Was the water a total failure this year?

Mr. HELFRICH. Yes.

The CHAIRMAN. How long have you been in this valley?

Mr. HELFRICH. About seven years.

The CHAIRMAN. And is that the first failure you have seen?

Mr. HELFRICH. Yes, the first complete failure. There are two ranches in the county that have natural wells or springs. Their owners have succeeded in raising regular crops this year just as if there was no trouble. They will make 4 tons of alfalfa, 2 tons to each cutting. I do not think the county this year will turn out more than 8,000 tons of hay, when we ought to turn out 12,000 or 15,000. We have a fine orchard on one of the ranches, but we have not water to irrigate it with.

The CHAIRMAN. Until Snake River is turned?

Mr. HELFRICH. Until Snake River is turned.

The CHAIRMAN. Did you say you had an estimate made to see what it would cost to take Snake River out there?

Mr. HELFRICH. No; but we had an estimate made on the South Bois , to take that out; and it would have to be by tunnel. That would cost about \$120,000.

The CHAIRMAN. Is there enough water there for irrigation purposes?

Mr. HELFRICH. Not unless we stored it. If we took it out, there would be none for down here.

STATEMENT OF M. H. ADAMS, OF CAMAS.

The CHAIRMAN. What is your occupation?

Mr. ADAMS. Raising cayuses and calves, cattle and hay.

The CHAIRMAN. Is there any irrigation in your county?

Mr. ADAMS. Yes, when we have water.

The CHAIRMAN. What stream do you irrigate from?

Mr. ADAMS. Camas Creek, Bingham County.

The CHAIRMAN. Of what is that a tributary?

Mr. ADAMS. It loses itself in the desert, and rises in the range of lakes between the Idaho line and Montana.

The CHAIRMAN. Could it be increased by reservoirs?

Mr. ADAMS. Yes; that is all we need in our country. We have a natural fall, and plenty of ditches. I have ditches to-day, but no water to put in them.

The CHAIRMAN. Have you examined the country above to see what chances there are to save the water?

Mr. ADAMS. Yes.

The CHAIRMAN. What are the chances generally?

Mr. ADAMS. Forty miles above me is what is called the Camas Mead-

ows; next to the base of the mountains it is level, and when it breaks through there it comes through the cañon and runs about 40 miles before it comes to the town of Camas.

The CHAIRMAN. Is that valley level enough so that a dam could be made so as to cover a large portion of it?

Mr. ADAMS. Half a township, very conveniently. The situation of our country is this: We have two rivers there, the Big Lost River and the Little Lost River, Birch Creek, Medicine Lodge, and the Camas. All those streams have their rise of water from the mountains along the line. They all sink in the desert. None of them come forth in the Snake River at all.

The CHAIRMAN. Are there opportunities on all of them for storage?

Mr. ADAMS. On every one of them; plenty of opportunities. The altitude of those mountains is from 7,000 to 8,000 feet, and that altitude is not high enough to hold snow. In the season of the year when we are in need of water it is gone. The Lost River will flow a good deal of water in the spring, but by July it is gone.

The CHAIRMAN. Is that land good land?

Mr. ADAMS. Very good land. I have ranched a little there for the last five or six years. My vegetables and oats are equal to any I have ever seen here. We are 4,800 feet in altitude. It is not so good for fruit, but all cereals and vegetables grow as well as they do here.

The CHAIRMAN. How much land could be brought under cultivation in that valley if you had a proper storage system?

Mr. ADAMS. Along the Camas and the Lost River it is from one to the other a distance of 50 miles across. There is plenty of land, and it is all productive if it had water.

Senator JONES. How does the water disappear from these rivers that you call the Lost Rivers?

Mr. ADAMS. It runs right into the lavas, and keeps sinking. In the Big Lost River it runs down on the cañons and after a while it is all exhausted. It seems as though this water in the Lost River lost itself in these lavas and breaks out again somewhere else. Undoubtedly the lava is above the sand and lime. That whole country is one system of storage, and has no connection with any other part of the country.

STATEMENT OF W. B. ALLEN, OF SHOSHONE.

The CHAIRMAN. How long have you resided at Shoshone?

Mr. ALLEN. About five or six years. It is in the heart of a desert, if there is a desert. This is in the very central portion of the lava beds, yet in our county we have over 1,000,000 acres of good arable land.

Senator JONES. How large is Logan County?

Mr. ALLEN. There are about one hundred and fifty townships, which would be 3,750,000 acres of land.

The CHAIRMAN. In the portion of the lava beds that you do not cultivate, the lava is on top?

Mr. ALLEN. Yes; and there it is broken in such a way that a canal could not be cut through to any great distance. Following the general course of the Snake River in the northeastern section of Idaho Territory, where it rises in Yellowstone Park, there is a great deal of fall. Lying on the north side of Snake River are the lava beds. The Oregon Short Line enters the county at the American Falls and comes due west. The land is largely devoted to grazing at the present time.

The CHAIRMAN. Have you irrigated some in your county?

Mr. ALLEN. We have. About 2 per cent. of our available agricultural lands are under cultivation. Camas Prairie is a level stretch of valley or meadow land about 12 or 15 miles in width and from 45 to 55 miles long; that is on the northern side of the county. That is fed by a number of little streams going from Camas Range or Wood River Range, and feeds that valley, which does not require so much irrigation.

The CHAIRMAN. Are these streams exhausted so far as irrigation is concerned?

Mr. ALLEN. Yes; they are.

The CHAIRMAN. Could you increase the irrigation by storage reservoirs.

Mr. ALLEN. Yes. Our theory has been that we were unable to get further in the way of irrigation except by aid from the Government or from large capital. I have been working to secure the unity of the whole people of the Territory for that purpose. We hope to convince your committee that Idaho has capacity of soil and climate and production to become a great State. The proposition is that we are almost helpless without other aid.

The CHAIRMAN. So far as the State question is concerned, it depends more on what you all want than on what we want.

Mr. ALLEN. We will be able to convince you all in regard to that by next winter.

Senator JONES. What benefit would statehood confer on you in regard to irrigation?

Mr. ALLEN. As a Territory we have not the means to issue bonds, whether for the State or the county, to support a system of irrigation.

Senator JONES. Do you think the State would do it if it were a State?

Mr. ALLEN. I have visited every section of the Territory and have made a careful study of this question, and was one of the first to agitate it and to endeavor to get this work of our local committee done. I am fully convinced that if it is given into the charge of the State it will be carried out faithfully and systematically. Otherwise we should have to depend on the General Government to cultivate and irrigate this whole agricultural region.

The CHAIRMAN. Have you ever had an estimate as to the cost of irrigating this body of land that you speak of?

Mr. ALLEN. The estimates run different in different localities.

The CHAIRMAN. Take your locality for example.

Mr. ALLEN. It will run from \$2.50 to \$7 an acre.

The CHAIRMAN. How many acres?

Mr. ALLEN. Perhaps three quarters of a million out of the million acres that it is possible to reclaim.

The CHAIRMAN. Suppose it costs \$7 per acre; if the State should construct the work—if it should cause a corporation to be organized, and have some shares of stock for each acre or each 10 acres, do you think the settlers would buy the water right for their land and pay for the land more than \$7 an acre?

Mr. ALLEN. They would willingly pay \$10 to \$25 an acre wherever the water is placed with the land.

The CHAIRMAN. Then what is the difficulty in the State taking it and selling it as fast as it may be constructed?

Senator JONES. The difficulty is, that there is no State?

The CHAIRMAN. Is that the point?

Mr. ALLEN. Yes. I think the land and water should be sold to each settler, not to exceed 160 acres. If Congress will grant to the State a sufficient quantity of this land, I should think, speaking for myself, that we could afford to pay the General Government back very liberally. If Congress is not liberal enough to grant to Idaho what it has granted to other States as swamp land, we can afford to pay \$1.25 per acre, as an estimate of its actual value.

The CHAIRMAN. What is the necessity of a grant of land to the State? Can not individuals take a grant of the land from the Government?

Mr. ALLEN. But there is no individual that will take 160 acres who can afford to expend \$10,000,000.

The CHAIRMAN. But if the State constructs the ditch the State will have the water?

Mr. ALLEN. Yes.

The CHAIRMAN. Then why can not the State sell the water and let the people get the land from the General Government under the homestead law?

Mr. ALLEN. It will be on the principle of some man building a dam for another party who owns the land.

Senator JONES. But when the other party proposes to give the land away, how is it then?

Mr. ALLEN. Well, that would be a little circuitous.

The CHAIRMAN. Would it not be better to have the homestead law apply and give a man 80 acres? If a man wanted 20 acres you could sell him water enough to water 20 acres. You fix your price so that it pays the cost of construction and a little interest, and then when it is all sold out the people would have it and there would be assessments enough to keep it in order. Is it not, therefore, better to leave it so, with the laws as they are regarding homesteads, and let the State build the ditches and deliver the water to sell.

Mr. ALLEN. But how can the State issue bonds to build the ditches?

The CHAIRMAN. It does not need to issue bonds. It can take \$100,000 and build a ditch.

Mr. ALLEN. That would build one ditch, perhaps.

The CHAIRMAN. But you don't want to build ditches any faster than the settlers want them. Here are 100,000 acres of land which perhaps can be irrigated for \$200,000. The State starts in with an appropriation of \$100,000 for that. That \$100,000 will irrigate some of the land. You then commence to sell the water rights. If no settlers come you do not need to dig any more. After settlers have come you can build more. The General Government will let them have the land; whereas if the State had the land would it not be likely to sell it in too large quantities?

Mr. ALLEN. The theory we have been following out is that the State should have the power to dig these canals.

The CHAIRMAN. It has.

Mr. ALLEN. And that it should also have the supervision over the rates to be charged.

The CHAIRMAN. You do not suppose it would have "rates?"

Mr. ALLEN. Well, it would have a charge.

The CHAIRMAN. Would it not be better to have the individual owners of the land become the stockholders in the water company?

Mr. ALLEN. The majority would consolidate.

The CHAIRMAN. How could they consolidate if you kept the water and the land together? Or if they wanted to consolidate the State could pass laws against it.

Senator JONES. Senator Stewart's idea is that the ownership of the water should be inalienable from the land, and that men could not sell or alienate the water right except by selling the land, and that when they did the man who had the land should have the water right.

Mr. ALLEN. It seems to us that it would take a great many years to carry that out, but that with the land a necessary amount of money could be raised sooner.

The CHAIRMAN. The land is only the instrument. The Government is willing to give them that. The Government is anxious that people should come and settle on the land; that does not cost anything.

Senator JONES. His idea is that if the Government should convey it to the State, the State could raise the money to construct these ditches more readily than could otherwise be done.

The CHAIRMAN. The State does not want security.

Senator JONES. The people who furnish the money would want some security.

The CHAIRMAN. I would not advise a State to have a scheme for getting into debt. If a State can raise \$100,000 or \$200,000, as this State can, I believe that \$200,000 would be all that you would want to reclaim these deserts—I would start with that capital. I would take an easy place and irrigate 50 or 60 acres of land, and commence the construction of a ditch, and to every one that went on that land I would sell a water right. I would do it gradually so as to get the State a fair return. At some places they could charge \$10 an acre, and at some places \$6 or \$7 an acre. When you sold to a man water with which to irrigate 40 or 50 acres of land, you would get your money. Then if the people came to buy it, you could extend it 3 or 4 miles, and then get your money. I don't think you should dig a ditch any faster than you could get the people to come and take it. You need not irrigate all the land before the people come.

Senator JONES. But every poor fellow who comes up for a homestead would not have the \$10 cash with which to get the water, whereas if they had time to pay—three or four years—they might do it. In the mean time the State's capital would be used up, and they would have to wait. Men who want homesteads have not many times \$10 an acre to spend that way.

The CHAIRMAN. The Government of the United States could allow a man to mortgage his property to the State, though I would never countenance a mortgage to individuals, because they might be unjust and exacting. I see no objection to the Government having a mortgage on it, however. If it is mortgaged to individuals who would not construct the ditch, it would be better not to have it mortgaged at all.

Mr. ALLEN. In our constitution we have provided that all the waters of the State are subject to public use, and we have provided that when, with the permission of Congress, this Territory becomes a State, it shall not go into debt.

The CHAIRMAN. That is very good.

Mr. ALLEN. But your proposition to build these canals would get us into debt more than our constitution allows.

The CHAIRMAN. How much can you go into debt under the constitution?

Mr. ALLEN. Not more than 1½ per cent., including our present debt. There are many details of this plan I spoke of that are not entirely clear. But it seems to me that the General Government might divide, say, one-half of the lands with the State.

The CHAIRMAN. The Government does not want to make anything out of the lands.

Mr. ALLEN. It might allow the State to make something out of them.

The CHAIRMAN. The Government does not want anybody but the settler to make anything out of them. If you could get a system started, you do not want much money to start with. My observation has shown that States have been ruined by taking their lands outside the protection of the land laws of the United States.

Mr. ALLEN. We have also provided that the public lands of the State granted by Congress heretofore, or hereafter, shall not be sold at a price less than \$10 per acre, nor more than 25 sections in any one year, nor in tracts exceeding 160 acres to any one settler. They may lease, if the State so chooses, in order to obtain a rental. I think Congress should give us a portion of those lands.

The CHAIRMAN. Whenever Congress wants to give you land do not ask it to put you in a position to sell the land to monopolists.

Mr. ALLEN. We have already arranged it so that that could not be done. We will go and see you next winter about it.

The CHAIRMAN. Most of your land is public land and you can fill this Territory up if you do not make any mistakes.

Mr. ALLEN. We have about 84,500 square miles in Idaho, equal to nearly 55,000,000 acres. We have 15,000,000 acres of agricultural land.

Running underneath the lava beds is an immense volume of water coming from seepage. In these lava beds there are localities where the water comes to the surface from Lost River, and I think you can trace that water from Lost River into the Shoshone Falls.

The CHAIRMAN. When you store the water in the mountains, will you not cut that off a good deal?

Mr. ALLEN. It would be impossible to cut off all of it. I estimate that there is not 1 per cent. of the water in the Territory that is used. For 700 miles Snake River flows around and through Idaho Territory, and it has along its extent a great many tributaries.

STATEMENT OF C. H. BASSETT, OF BINGHAM COUNTY.

The CHAIRMAN. Where do you reside?

Mr. BASSETT. In the southeastern part of Bingham County, on the Bear River.

The CHAIRMAN. Do the waters from your county flow into Bear River and down to Salt Lake?

Mr. BASSETT. Yes.

The CHAIRMAN. What is your occupation?

Mr. BASSETT. I am a farmer and rancher.

The CHAIRMAN. You cultivate land by means of irrigation, do you?

Mr. BASSETT. Yes.

The CHAIRMAN. What kind of crops do you raise on that farm?

Mr. BASSETT. We do not raise much but grain, vegetables, and some small fruits.

The CHAIRMAN. Do you raise those successfully?

Mr. BASSETT. Yes.

The CHAIRMAN. What amount of grain do you raise to the acre?

Mr. BASSETT. That part that is irrigated thoroughly and is given good care will average about 50 bushels of oats, 40 bushels of wheat, and 60 bushels of barley.

The CHAIRMAN. Do you raise vegetables in abundance in this Territory?

Mr. BASSETT. Yes; very fine vegetables.

The CHAIRMAN. Do you raise apples ?

Mr. BASSETT. We raise some apples there, but I don't think any peaches are raised.

The CHAIRMAN. State whether the supply of what you grow is abundant ?

Mr. BASSETT. It has always been so until this summer. The river has been very low this year, and if the company had not appropriated Bear Lake as a reservoir there would have been half a dozen canals.

The CHAIRMAN. Did some company appropriate Bear Lake ?

Mr. BASSETT. Yes ; the papers report that an irrigating company has appropriated Bear Lake, and have scared many people away from it.

The CHAIRMAN. Under what law was it appropriated ? It was reserved two years ago.

Mr. BASSETT. I do not know as to the law. They are appropriating under a law of the Territory, they claim.

The CHAIRMAN. It is public land, is it not, and belongs to the United States ?

Mr. BASSETT. Yes ; I presume so.

The CHAIRMAN. The United States said two years ago that no private individual could appropriate it.

Mr. BASSETT. Then I hope that the United States will stick to its word. I know to my certain knowledge of three companies that would have taken out canals had it not been for that.

The CHAIRMAN. Bear Lake is now a reservation and has been so for two years.

Mr. BASSETT. If the Government would make a reservoir of Bear Lake, the people out there would take out the canals themselves.

The CHAIRMAN. Suppose the Government should make the reservoir and do nothing more ; all could participate in it then. Could the people not combine and make a reservoir themselves ?

Mr. BASSETT. No ; I do not think they would ; not now at any rate. It would take probably two or three hundred thousand dollars.

The CHAIRMAN. To build a dam ?

Mr. BASSETT. To build the right kind of dam, probably. And the water has been so low in the river this year that it discouraged the people. There have, however, been several canals taken out.

The CHAIRMAN. With Bear Lake used as a reservoir, irrigation could be pretty extensively practiced, could it not, in the county ?

Mr. BASSETT. Yes ; I made several surveys myself, and took up some of the land down there, but there was no water and I got scared out.

The CHAIRMAN. If that country is to be developed prosperously the storage system is a necessity, is it ?

Mr. BASSETT. Yes ; an actual necessity.

FURTHER STATEMENT OF ALECK DANSTIN.

The CHAIRMAN. Bingham County is largely irrigated, is it not ?

Mr. DANSTIN. Considerably ; but there is only a small portion of it that can be irrigated.

The CHAIRMAN. About what extent of land can be irrigated in that county ?

Mr. DANSTIN. I think Mr. Foote's estimate was about something like 300 or 400 acres.

The CHAIRMAN. Is it good land ?

Mr. DANSTIN. Yes.

The CHAIRMAN. By what process would you irrigate it?

Mr. DANSTIN. By taking the water from Snake River principally. There are other small streams there that ditches are taken from, but it is principally from Snake River that they have to be irrigated.

The CHAIRMAN. Have they increased the volume of those by reservoirs at all?

Mr. DANSTIN. Not at all.

The CHAIRMAN. Is there any opportunity to do it?

Mr. DANSTIN. Yes; there is a very good chance to do it.

The CHAIRMAN. Is the scheme of taking it out of the Snake River very expensive?

Mr. DANSTIN. Not in proportion to the amount of land that could be irrigated.

The CHAIRMAN. About how much would it cost per acre?

Mr. DANSTIN. About from \$2 to \$5 an acre.

The CHAIRMAN. Suppose it would cost \$5 an acre, would homestead settlers on the land buy a right in it for \$5 an acre?

Mr. DANSTIN. Yes; I think so.

The CHAIRMAN. Do you think that place would be settled up rapidly if that were done?

Mr. DANSTIN. Very quickly.

The CHAIRMAN. If any person would construct a ditch and reservoir you think the water would sell readily for \$5 an acre?

Mr. DANSTIN. I think it would.

The CHAIRMAN. And \$5 an acre would certainly do it?

Mr. DANSTIN. My opinion is that it could be done for that very easily, taking it on a large scale.

The CHAIRMAN. What is the character of the land? Is it productive?

Mr. DANSTIN. It is. It is very much such land as you see this fruit growing on [referring to fruit on table].

The CHAIRMAN. Do you raise fruit there the same as they do here?

Mr. DANSTIN. Pretty much the same, although the country there is younger.

The CHAIRMAN. It is a little cooler there than it is here?

Mr. DANSTIN. A little bit; but I think you can raise there everything that can be raised here.

The CHAIRMAN. It is equally fertile with this land?

Mr. DANSTIN. I think it is.

The CHAIRMAN. What is a fair crop of wheat to the acre?

Mr. DANSTIN. About 40 bushels.

The CHAIRMAN. And of barley and oats?

Mr. DANSTIN. Barley about 60, and oats probably 75 bushels.

The CHAIRMAN. What is a fair average crop of potatoes?

Mr. DANSTIN. About 300 bushels to the acre would be a fair crop, although there has been twice that much raised on an acre. Taking, however, a good, fair average crop, about 300 bushels per acre would be right.

The CHAIRMAN. How much irrigated land do you think a family ought to have to make a good living, if they cultivated it well?

Mr. DANSTIN. It would vary a good deal, but on that kind of land I think they could make a good living on 40 acres.

The CHAIRMAN. Would 40 acres there be as good as 160 acres in Kansas or Nebraska?

Mr. DANSTIN. I think it would be better. From what I have heard I

think 40 acres there with water on it would be as good as 160 acres in Kansas, and would produce more in fact.

The CHAIRMAN. Have you been a farmer?

Mr. DANSTIN. Yes; though I do not farm at the present time.

The CHAIRMAN. What did you raise on your farm?

Mr. DANSTIN. It is a number of years since I farmed. I have been engaged lately in ditching in Blackfoot and in surveying and work of that kind. I have been working on ditches for the past three years.

The CHAIRMAN. Do you think there is an abundance of water by storage and ditches together in Snake river to irrigate a large section of the country?

Mr. DANSTIN. I think there is, providing it is stored. There is going to be a scarcity there in a few years if it is not stored. At the present time there is a great scarcity.

The CHAIRMAN. They do not store so much as they litigate now?

Mr. DANSTIN. That is what they are doing now. Their idea for the remedy for the scarcity of water is to sue one another. I am now engaged in distributing water on a small stream between parties who have been in litigation for a year. If this storage system were carried out there would be no occasion for litigation. I think there is water enough there to be used.

The CHAIRMAN. If they do not let it run away in the flood time you think there is enough?

Mr. DANSTIN. There is enough to irrigate three times the amount of acres that it can be utilized for as it is.

The CHAIRMAN. You think the storage system would not only supply these farmers, but three times more?

Mr. DANSTIN. Yes.

The CHAIRMAN. Without going to Snake River at all?

Mr. DANSTIN. On those small streams; and then also the Snake River. It will be an actual necessity in a few years to have storage on that river. There is an abundance of water there now, but if it keeps going it will be quite small after awhile.

STATEMENT OF JOHN ANDREW O'FARRELL.

The CHAIRMAN. You are a miner and prospector?

Mr. O'FARRELL. Yes.

The CHAIRMAN. And have traveled pretty much all over this Territory?

Mr. O'FARRELL. Yes.

The CHAIRMAN. And have lived here for a good many years?

Mr. O'FARRELL. Since 1863.

The CHAIRMAN. What was the condition of this valley where these orchards and vineyards now are, at the time you first saw it?

Mr. O'FARRELL. It was a dry sand-bar, like a wash-out. Nothing could make a living on it hardly, except that a toad would be sometimes found near one of the little springs.

The CHAIRMAN. What has produced the change that we see?

Mr. O'FARRELL. The use of water.

The CHAIRMAN. Do you find similar changes in other parts of the Territory? Where you put water on the land does it become fertile as it has become here?

Mr. O'FARRELL. Everywhere.

The CHAIRMAN. Have they been able to produce trees and orchards and all sorts of crops all over the Territory?

Mr. O'FARRELL. Everywhere where the water is used for irrigation and properly attended to, the product is the same. It is really marvellous.

The CHAIRMAN. Of course there are some places that are a little more fertile than others and easier to irrigate?

Mr. O'FARRELL. Yes.

The CHAIRMAN. Have you traveled over the mountains generally, and observed their conformation with regard to the storage of water in Idaho?

Mr. O'FARRELL. Yes; I have given that subject particular attention within the last six years.

The CHAIRMAN. What have been the general opportunities for storage that you have observed?

Mr. O'FARRELL. Just north and east of where we now are surpasses any part of the State of Colorado, and I have traveled that whole State as a miner and farmer. I was for two seasons there.

The CHAIRMAN. Describe the condition of the mountains at the headwaters, and those streams as a general rule; what are the general features of the country?

Mr. O'FARRELL. The country is a rolling, mountainous country, heavily clothed with timber. The cañon of the South Branch of the Payette and the Bois  meet on the same dividing ridge; the ridge is very abrupt and the distance from the head of one stream to the other is very short. The Salmon River empties itself on the eastern side of the range and along the Bitter-root Valley. The Salmon, Bois , and Payette come into the same valley.

The CHAIRMAN. Are these mountains high, so that they gather a good deal of moisture?

Mr. O'FARRELL. Yes.

The CHAIRMAN. Are high mountains and plenty of snow characteristic of this Territory?

Mr. O'FARRELL. They are in the portion of the Territory to which you refer. I would say that at these particular places there are quite a number of lakes, and those lakes look as though they now occupied the places of extinct volcanoes. They are elevated high up in the mountains. The lakes could by a rampart or dam be made to hold a vast quantity of water.

The CHAIRMAN. You found lakes at the headwaters of what streams?

Mr. O'FARRELL. Of all the streams; the Payette, the Bois , and the Salmon.

The CHAIRMAN. Are those lakes numerous?

Mr. O'FARRELL. On the South Bois , in one of the Table Mountains, there are, I think, seven lakes. One is quite large; standing on an elevated plateau of land, and by very little work all the water could be taken from those lakes on to the Salmon River; but its natural flow is to the South Bois  stream.

The CHAIRMAN. The South Bois  covers a good deal of land if it can give sufficient water?

Mr. O'FARRELL. Yes.

The CHAIRMAN. Is the land valuable?

Mr. O'FARRELL. Yes; but by storage there could be much more made valuable.

The CHAIRMAN. Have you been up to the head of the Snake?

Mr. O'FARRELL. Yes; and all through the National Park.

The CHAIRMAN. What is the opportunity up there for lakes for storage?

Mr. O'FARRELL. If dams were constructed on Lake Jackson and other places, it would be one of the mammoth storing places for water on the Rocky Mountain range.

The CHAIRMAN. By "mammoth" you mean very large?

Mr. O'FARRELL. Immense.

The CHAIRMAN. Are the mountains high, so as to gather very much snow?

Mr. O'FARRELL. Very high. The shed of the Tetons empties all its water into the lake.

The CHAIRMAN. Have you been into the southern part of the Territory and south of the Snake and towards the Utah and Nevada line?

Mr. O'FARRELL. Yes.

The CHAIRMAN. How is that watered?

Mr. O'FARRELL. At the head of the Owyhee River the country is very level, and forms a basis similar to the Boisé basin here, but the mountains in the vicinity are not so high.

The CHAIRMAN. They do not collect so much snow.

Mr. O'FARRELL. They do not collect so much snow, or at any rate so much snow does not lie there. But the water that comes from the channel of the Owyhee, if stored, would cover the whole valley of the Humboldt.

The CHAIRMAN. They could go into Nevada State?

Mr. O'FARRELL. Yes, the "Bull's Run trail," as they call it, is the lowest pass, and when you form a dam right down there at those several little branches of the Owyhee, you will throw the whole of the water into the Nevada valley, and I believe it would not require twenty feet.

The CHAIRMAN. What are the characteristics of the Payette River?

Mr. O'FARRELL. From what I have seen in the Territory of Idaho, I have been on no stream that has the same natural advantages for easy work and cheap irrigation as the Payette has. The country of itself and the surroundings are generally better, and the stock range, above the line of any canal that could be constructed there, is more extensive than anywhere that I know of for any of the projected canals.

The CHAIRMAN. Have you any other suggestions to make about irrigation?

Mr. O'FARRELL. As you have asked me about the Payette, I may say that I have been down there, and those who go down there can not ordinarily see one-fourth of the area that the water will cover, because on the north side when you run to Willow Creek there is a rough, irregular ditch there, and you can go through that and get into a table land between the Weser Valley and Payette Valley.

The CHAIRMAN. How much of that table land?

Mr. O'FARRELL. A friend of mine and myself estimated 150,000 acres as the extent of ground upon which that water could be utilized. The lower part of the Payette, however, he estimated at 200,000 acres.

The CHAIRMAN. You have 350,000 acres then, altogether?

Mr. O'FARRELL. That was Mr. Kinney's estimate.

The CHAIRMAN. Have you estimated how much it would cost per acre to irrigate that?

Mr. O'FARRELL. Yes; for the lower lands on the south side of the river it would cost \$1.60 per acre, and for the higher lands on the north side of the river, including the difficulty of getting through this pass, it would cost about \$3.30 per acre. I had the thing reduced to figures by Mr. Kinney, who was a very practical man.

The CHAIRMAN. If the whole 350,000 acres can be reclaimed for \$5

per acre, would there be any difficulty in selling the water rights at \$5 per acre?

Mr. O'FARRELL. Not in that locality. As fast as you can get the water in the country you can get it settled up.

STATEMENT OF W. A. RANKIN, OF BOISÉ CITY.

The CHAIRMAN. What is your occupation?

Mr. RANKIN. I was brought up a tiller of the soil.

The CHAIRMAN. Have you traveled through this region of country here where the timber grows?

Mr. RANKIN. I have, through Nevada, California, and Idaho.

The CHAIRMAN. Have you seen forest fires in Idaho, Montana, Washington Territory, and Oregon, and have they been very destructive?

Mr. RANKIN. Yes; they have been very destructive this season; more so than usual. I have just returned from a 150-mile trip north of this Territory and found that the fires are very destructive.

The CHAIRMAN. How does the amount of timber destroyed by fire compare with the amount used by the people?

Mr. RANKIN. I think there will be more timber consumed by fire during 1889 than all that has been consumed by the inhabitants of Idaho Territory from its organization.

The CHAIRMAN. Can you suggest any way by which the General Government can assist in protecting the forest?

Mr. RANKIN. I can suggest a plan, I think.

The CHAIRMAN. Tell us what your plan is?

Mr. RANKIN. It is that there should be something like local commissioners; that is, a commissioner to be chosen from among the citizens in the different localities or timber districts, and that they should have some appropriation, either from the General Government or from some other source, so that they could pay men for labor performed to prevent fires. These fires come from carelessness of parties who go into the mountains to hunt, fish, prospect, etc.; whereas if there was some one to follow tourists up immediately, these fires could be checked.

The CHAIRMAN. How would you do it?

Mr. RANKIN. It could be done in many places by a few buckets of water, sometimes by doing a little shoveling around a big pine tree.

The CHAIRMAN. Over so large an area, would not that method require a large number of persons as guards?

Mr. RANKIN. Not a great many. One man could follow along a mountain range where this is occurring, and could put out a great many fires in a day's walk.

The CHAIRMAN. After the fires got started to some extent he could not accomplish much?

Mr. RANKIN. No; he could not.

The CHAIRMAN. In what portions of the year do fires occur?

Mr. RANKIN. There are only about ninety days in the year when these fires are dangerous and destructive. If kept subdued for that dry period (during the months we will say of July and August and part of September), fires would not trouble the forests of the country at other seasons, because there is more or less rain-fall. High in the mountains in September there is often considerable snow that will put out fires.

The CHAIRMAN. Then your idea is to have local commissioners or officers in convenient districts with power to employ persons during the fire season?

Mr. RANKIN. Yes; to employ help when it became necessary.

The CHAIRMAN. Would it be agreeable to the people if all the timber lands were withdrawn from sale, and every man was allowed to cut timber, provided he would comply with the regulation, and leave the undergrowth untouched?

Mr. RANKIN. I think it would meet with the full approbation of the pioneers of the West.

The CHAIRMAN. If people were allowed to cut what they wanted for their own use, or for any use, would they be willing to pay sufficient stumpage to re-imburse the Government for the expense of guarding the forests?

Mr. RANKIN. Yes; I believe they would be all willing to do it.

FURTHER STATEMENT OF ALANSON SMITH.

The CHAIRMAN. I understand you wish to add something to the testimony you have given. I see there is quite a difference of opinion in regard to the number of acres of arable land. By arable land I understand that which can be made to subserve the plow, and does not consist entirely of sage-brush land. Land that can be made to produce crops by irrigation is arable land.

Mr. SMITH. I include in the arable land of Idaho a very large surface, although small in comparison with the whole. There is a large surface of land covered to some extent with timber, perhaps small timber. I refer to the lands from which you can cut down the timber and have part of the land for grass. I have been making estimates since 1875, when I first attempted to make an estimate in regard to the capacity and resources of this country. My estimate of the arable land of Idaho would be larger than that made by Mr. Dubois and others, because I include in arable land all land that is capable of cultivation by any ordinary means.

The Valley, as it is termed, is reported here to be from 60 to 80 miles long and 10 miles wide. That makes about 600 or 800 square miles. I have traveled all over that country—all the river and its tributaries (and there are some large streams running into the main Payette River), and I believe that in extent it is at least equal to the State of Delaware, and that is about 2,000 square miles. The arable portion of it is about equal to the State of Rhode Island. In that I include not only the grass land which I rode through for miles, but I have also included the lands along the tributary streams, which include land, a good deal of land, covered with small timber; but if the timber were cut off and the land cultivated, it would produce the best kind of crops.

I place the arable land of Idaho as high as at least 20,000,000 acres. That is about one-third of the whole Territory. I am fortified in this estimate by the land that I have seen in the Walla Walla region and in northern Idaho. I took a great deal of pains, in northern Idaho, to ascertain the facts regarding the amount of cultivable land. I set down the area of northern Idaho as equal to all the arable land of New England. I place the arable land of the whole Territory, including the lands easily cleared of timber, as equal to the whole of the arable lands of New York and Pennsylvania put together. I believe that is how the Census Reports of 1870 placed it. My object has been not to enhance the value of the Territory beyond what it deserved, and I make this statement in order that I might be right upon the record with regard to this point, as I have investigated the subject for the last fourteen years.

STATEMENT OF FRANK GREENE, SECOND LIEUTENANT, SIGNAL CORPS, U. S. ARMY.

My views upon the subject of irrigation are based upon an experience of several years' duty in the Northwest and some personal investigation of the question of wheat growing without irrigation.

When the annual precipitation falls to or below 12 inches, irrigation will be found necessary, although, as shown in Senate Ex. Doc. No. 229, Fiftieth Congress, first session, the mean annual precipitation at Walla Walla, Wash., in the heart of the Columbia River wheat basin, is but 17 inches.

That the dry sage-brush land of the west will, when watered, produce an ample crop, is shown in the same document, page 16, the bunch-grass land averaging 25.3 bushels of wheat per acre, and the mixed bunch-grass and sage-brush land 25.7 bushels per acre.

For the growth of cereals irrigation will be found necessary principally in the months of March, April, and May, and to a more limited extent in June. After this time, for the remainder of the year, it would, for this purpose, be unnecessary, although, to render a region habitable, it must be continued the year round. It would seem, then, that the most important problem would be the securing of ample water supply in the first half of the year.

Where a large river with considerable fall passes through a region such as the Snake River in southern Idaho and eastern Oregon, it appears practicable to supply large tracts of land on each side with water for irrigation by a system of tapping the river at well-selected points above, to water the lands lying below. If a low-lying dam, of only sufficient height to direct the water into the acequia during the low-water stage, from November to the last of May, can be protected against the first few feet of rise over its top in the June rises, the matter of protecting the mouth of the acequia against high water will not be difficult and a means of obtaining a constant water supply will be found.

When no supply from a stream is available, the question of a water-supply may yet be solved in some of the interior basins by the artesian well.

To a limited extent, water can be elevated above the level of the acequia to a distance equal to the radius of the wheel that the current in the acequia will revolve, by means of the well-known irrigating water-wheel, such as is used so successfully in Boisé City, Idaho.

It may not be amiss even to speak of the clearing of the sage-brush land, always a task involving much labor. I have seen such land rapidly cleared by dragging over it the bight of a stout iron chain, to each end of which oxen are hitched, the smaller sage-brush being torn out at once by the roots, while a man following in the rear, with the tap of an ax to the top roots, readily releases the hold of the larger brush.

STATEMENT OF JAMES M. COOK, SECRETARY OF THE REXBURG AGRICULTURAL AND HORTICULTURAL ASSOCIATION, REXBURG, BINGHAM COUNTY.

All lands in our section require irrigation to produce crops. There is yet considerable land without water, but in most instances where it is convenient to get water the land is under claim.

Six years ago, February, 1883, this district, which lies between the

forks of the north and south forks of the Snake River (it is 22 miles east from Market-Lake Depot to Rexburg), first began to settle up, and a large quantity of land has been taken up by settlers. They continue to do so where an opening occurs and there is any prospect of getting out ditches. I am unable to give the extent of land yet without water, but can say our country is large, extending some 30 to 40 miles, perhaps 50 miles by 20 to 25 miles, more or less under water or now in contemplation of such advantage.

The average rain-fall is very light, especially in the earlier parts of the year. Some winters we have considerable snow. The last two winters have been exceptions and we have had doubts of our streams holding out for irrigation.

In Rexburg we have two canals, each recorded to be 20 feet wide in the bottom, and each able to carry 8,000 inches of water. Rexburg contains about two hundred lots of $2\frac{1}{2}$ acres each. The estimated water-right required per lot is \$20. The estimate for farm lands is \$2 per acre.

The upper canal is taken out of the Geton River (south fork) 3 miles above Rexburg, and is some 7 feet higher than the lower one, which is taken out opposite Rexburg and is used mostly for the farm lands, which it strikes about 1 mile from the river.

Dams of rock are required in the river by both canals so as to continue the supply to the end of irrigation time. The upper canal has a head-gate 10 feet wide; the lower one a head-gate 20 feet wide.

By March, 1888, these two canals had cost \$15,400, which was mostly credited to labor for those who wanted water. Our canals are made by those who want water. Some little delay is caused on account of the scarcity of capital, in the final completion of ditches. On March 26, 1888, it was decided to cancel half the amount of the cost of Rexburg canals, which has reduced the cost to \$7,700.

Our canals to date having cost by amount after cancelled \$8,000.

The water estimate at the recording of our canals was 1 inch per acre under 4-inch pressure. We estimated to take under them some 16,000 acres.

The estimate of \$20 per lot and to \$2 per acre is raised on the amount now recognized, viz, \$8,000 as cost of canals, assessments for cleaning out and repairing for 1889 was one day's work with team for 10 acres of land, and the same for one city lot. There is also a cash tax for water master's fees of 10 cents per acre cultivated land and of \$1 per city lot.

We have always had a good supply of water. This is distributed by the water master, who is allowed his own discretion and judgment in all cases. In no case have we had to measure out our water. Two waterings, or at most three, is sufficient for grain crops. The manner of holding water property here in Rexburg as been up to the present by book account, which was transferable at the will of the owner, the secretary being appointed at the same time as the water master, the third Monday in March. I have been secretary of the Rexburg Irrigation Company since the date of its commencement in spring of 1883. There is somewhere about 5,000 acres at present under our canals. We have other canals around here; two near Rexburg, two or three at Lyman, 8 miles south. There are two or three or more at Teton, 8 miles east; the same at Salem, 3 miles north; Welford, and at other places about 11 miles northeast. All the supply of water is mostly taken from the Teton River, whose source is at the Teton Peaks, or a little south of that ridge of mountains. The stream forks some 9 miles east of Rexburg, one fork going a little south and the other a little north, both forks entering the Snake

River north of where the north and south forks of the great Snake River meet. On the Teton Island, as between the forks of the Teton River is called, there is quite a number of canals; some two or three are interested together, and in other instances five or six, and so on till we get to our larger ditches. The greatest fear we have is as to the extent of the Teton River. There is no doubt that more water is recorded and claimed than it holds, especially after it has lowered considerably, which it does do in June.

It would be good if something could be done to insure the supply. It has been contemplated to connect Fall River with the Teton, which would take some 6 miles of rather heavy canal, after which a natural swale or channel would form a good canal. Fall River lies some 20 or 30 miles east of Rexburg, is a faster stream and carries more water than the Teton. It could be relieved of half its contents and leave enough to irrigate the level lands that it passes through.

Teton, 8 miles east of Rexburg, has been trying to get a canal out of Cañon Creek, some 12 or 14 miles, for five years past. Cañon Creek is a stream that lies very low, its channel being cut in lava rock. This canal would cover some of the prettiest land around here, some 2,000 or 3,000 acres. It is rather expensive to make canals through rock on the side of cliffs. Assistance would be near to charity in this instance.

All vegetables and grain crops are grown with irrigation. Nothing would mature without it, only where the rivers overflow at high-water time, which produces hay, some trees and willows, which are mostly on the river bottoms.

Out of the valley rolling hills are found, and after average winters of snow we have a fair pasture of bunch grass. In the last six years there has been a large quantity of land brought under cultivation by means of water. Every year brings to light some new enterprise or some large canal enterprise. All the canals have been built by those who are making homes for themselves. We have a net-work of ditches all through the country, or, as it is termed, between the forks of the Snake River on the south side of the river and on to Eagle Rock. On the south side of the Snake they have had more speculative companies than we have had around Rexburg. All the cry is for water, water. Every one wants water; nothing can grow without it.

STATEMENT OF FRANK B. ANDREWS, SECOND LIEUTENANT FOURTH INFANTRY, U. S. ARMY, BOISÉ BARRACKS.

Reservoirs, of necessary size, to be constructed and filled from the large streams through ditches. If constructed by erecting a dam across any of the streams, a sudden rise in the water might cause the dam to give way and loss of property result. Size and direction of ditches leading from reservoirs would of course depend upon conditions obtaining in particular locality. If Congressional action could be had with a view to transferring to a State or Territory all public lands which should be certified by a surveyor (under employ of the General Government) as having been actually reclaimed by the State, authority granted for the issue of bonds to defray expense of such reclamation, bonds to be redeemed by proceeds of sale of land granted as above, it would seem as though the work would be thoroughly done. Each State would hasten the reclamation of all lands within its borders in order to secure the earliest settling. If, then, each State should adopt laws similar to those of Colorado, dividing the State into districts, each

one under charge of a water commissioner, who should be under orders of and report to the State engineer, the amount of arid land in the country would in the shortest practicable time be reduced to a minimum.

Adjourned.

WATER RIGHTS UNDER PROPOSED STATE CONSTITUTION.

The following provisions of the constitution adopted by the people for the proposed State of Idaho were filed with the committee by the secretary of the constitutional convention:

ARTICLE I.—*Bill of rights.*

SEC. 14. The necessary use of lands for the construction of reservoirs, or storage basins, for the purposes of irrigation, or for rights of way for the construction of canals, ditches, flumes, or pipes, to convey water to the place of use, for any useful, beneficial, or necessary purpose, or for drainage, or for the drainage of mines, or the working thereof, by means of roads, railroads, tramways, cuts, tunnels, shafts, hoisting works, dumps, or other necessary means to their complete development, or any other use necessary to the complete development of the material resources of the State, or the preservation of the health of its inhabitants, is hereby declared to be a public use, and subject to the regulation and control of the State.

Private property may be taken for a public use, but not until a just compensation, to be ascertained in a manner prescribed by law, shall be paid therefor.

ARTICLE XV.—*Water rights.*

SEC. 1. The use of all waters now appropriated, or that may hereafter be appropriated, for sale, rental, or distribution; also of all water originally appropriated for private use, but which after such appropriation has heretofore been or may hereafter be sold, rented, or distributed, is hereby declared to be a public use, and subject to the regulation and control of the State in the manner prescribed by law.

SEC. 2. The right to collect rates or compensation for the use of water supplied to any county, city, or town, or water district, or the inhabitants thereof, is a franchise, and cannot be exercised except by authority of and in the manner prescribed by law.

SEC. 3. The right to divert and appropriate the unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right as between those using the water; but when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purposes shall (subject to such limitations as may be prescribed by law) have the preference over those claiming for any other purpose, and those using the water for agricultural purposes shall have preference over those using the same for manufacturing purposes. And in any organized mining district, those using the water for mining purposes or milling purposes connected with mining shall have preference over those using the same for manufacturing or agricultural purposes. But the usage by such subsequent appropriators shall be subject to such provisions of law regulating the taking of private property for public and private use as referred to in section 14 of article 1 of this constitution.

SEC. 4. Whenever any waters have been or shall be appropriated, or used, for agricultural purposes, under a sale, rental, or distribution thereof, such sale, rental, or distribution shall be deemed an exclusive dedication to such use; and whenever such waters so dedicated shall have once been sold, rented, or distributed to any person who has settled upon or improved land for agricultural purposes with the view of receiving the benefit of such water under such dedication, such person, his heirs, executors, administrators, successors or assigns, shall not thereafter, without his consent, be deprived of the annual use of the same, when needed for domestic purposes, or to irrigate the land so settled upon or improved, upon payment therefor, and compliance with such equitable terms and conditions as to the quantity used and times of use as may be prescribed by law.

SEC. 5. Whenever more than one person has settled upon or improved land with the view of receiving water for agricultural purposes, under a sale, rental, or distribution thereof, as in the last preceding section of this article provided, as among such persons priority in time shall give superiority of right to the use of such water in the numerical order of such settlements or improvements; but whenever the sup-

ply of such water shall not be sufficient to meet the demands of all those desiring to use the same, such priority of right shall be subject to such reasonable limitations as to the quantity of water used, and times of use, as the legislature, having due regard both to such priority of right and the necessities of those subsequent in time of settlement or improvement, may by law prescribe.

SEC. 6. The legislature shall provide by law the manner in which reasonable maximum rates may be established to be charged for the use of water sold, rented, or distributed for any useful or beneficial purpose.

TERRITORIAL LAWS OF DAKOTA IN RELATION TO WATER AND WELLS.

[In force in both States—South and North Dakota.*]

POLITICAL CODE—TERRITORY OF DAKOTA, 1887.—Article 4. *Water rights.*

Sec.
2029. Person holding land has right to water.
2030. Right of way for conducting water.
2031. Right of way limited.
2032. Controversies, how determined.
2033. Deterioration or diminution of waters not to be considered.

Sec.
2034. Damaging lands—penalty for.
2035. Abandoned water-right; bridging ditches.
2036. Failure to comply with provisions of last section.
2037. Manner of locating water-rights.
2038. When abandoned.

SEC. 2029. Any person or persons, corporation or company, who may have or hold a title or possessory right or title to any mineral or agricultural lands within the limits of this Territory shall be entitled to the usual enjoyment of the waters of the streams or creeks in said Territory for mining, milling, agricultural, or domestic purposes: *Provided*, That the right to such use shall not interfere with any prior right or claim to such waters when the law has been complied with in doing the necessary work.

SEC. 2030. When any persons, corporation, or company owning or holding land, as provided in section 2029, shall have no available water facilities upon the same, or whenever such lands are too far removed from any stream or creek to so use the waters thereof as aforesaid, such person or persons, corporation or company shall have the right of way through and over any tract or piece of land for the purpose of conducting and conveying said water by means of ditches, dykes, flumes, or canals, for the purpose aforesaid.

SEC. 2031. Such right to dig and construct such ditches, dykes, flumes, and canals over and across the lands of another shall only extend to so much digging, cutting, or excavation as may be necessary for the purposes required.

SEC. 2032. In all controversies respecting rights to water under the provisions of this act the same shall be determined by the date of appropriation as respectively made by the parties, whether for mining, milling, agricultural, or domestic purposes.

SEC. 2033. The waters of the streams or creeks of the Territory may be made available to the full extent of the capacity thereof for mining, milling, agricultural, or domestic purposes, without regard to deterioration in quality or diminution in quantity, so that the same do not materially affect or impair the rights of the prior appropriator.

SEC. 2034. Any person or persons, corporation or company, damaging or injuring the lands or possessions of another by reason of cutting or digging ditches or canals or erecting flumes as provided by section 2030, the party so committing such injury or damage shall be liable to the party so injured for the actual damage occasioned thereby.

SEC. 2035. This act shall not be so construed as to impair or in any way or manner interfere with the rights of parties to the use of the waters of such streams or creeks acquired before the passage of this act: *Provided*, That all water rights or ditches that have not been used or worked upon for one year next prior to the passage of this act shall be deemed abandoned and forfeited and subject to appropriation anew. Any person or persons, corporation or company who may dig any ditch or canal, dyke, or flume over or across any public road, trail, or highway, or who use the waters of such ditch, dyke, flume, or canal shall be required to bridge the same and keep the same in good repair at such crossing or other places where the water from any such ditch, dykes, flumes, or canals may flow over or in anywise injure any road, trail, or highway, either by bridges or otherwise.

SEC. 2036. Any person or persons, corporation or company offending against section 2035, on conviction thereof shall forfeit and pay for every such offense a penalty of

not less than twenty-five dollars nor more than one hundred dollars, to be recovered with costs of suit in civil action in the name of the Territory of Dakota, before any court having jurisdiction. One-half of the fine so collected shall be paid into the county treasury of the county in which the offense was committed, and the other half shall be paid to the person or persons informing the nearest magistrate that such offense has been committed. All such fines and costs shall be collected without stay of execution, and such defendant or defendants may by order of the court be confined in the county jail until such fine and costs have been paid.

SEC. 2037. Any person or persons, corporation or company appropriating the waters of any streams or creeks in this Territory, shall turn the water from the channel of such creek or stream, and construct at least twenty feet of ditch or flume, within thirty days from the date of appropriation, and turn the water therein; and construct at least twenty rods of said ditch or flume, if needed, within six months from the date of such appropriation, and turn the water therein; and within twenty days from the date of location, the locator or locators of such water right shall file a location certificate thereof with the register of deeds in the proper county within which such water right is situated; a copy of such certificate shall be posted at or near the head of such ditch, flume, or canal, and shall contain the name or names of the locators, the date of location, number of inches of water claimed or appropriated, and the purpose of the appropriation; and in no case shall the number of inches of water claimed exceed the conveying capacity of the first twenty feet of the flume or ditch, nor shall said ditch or flume be enlarged to the prejudice or injury of a subsequent appropriator before such enlargement.

SEC. 2038. On failure to commence the construction of such ditch or flume for sixty days after location, and prosecute such ditch, canal, or flume to final completion without unnecessary delay, such appropriation shall be deemed abandoned.

CIVIL CODE—CHAPTER 3.—1887.—*Servitudes.*

SEC. 2760. The following land burdens or servitudes upon land may be attached to other land as incidents or appurtenances, and are then called easements:

4. The right of way.
5. The right of taking water, etc.
9. The right of receiving water from or discharging the same upon land.
10. The right of flooding land.
11. The right of having water flow without diminution or disturbance of any kind.

ARTICLE I, TITLE 3.—*Rights and obligation of owners.*

SEC. 2771. The owner of land owns water standing thereon or flowing over or under its surface, but not forming a definite stream. Water running in a definite stream, formed by nature over or under the surface, may be used by him as long as it remains there; but he may not prevent the natural flow of the stream, or of the natural spring from which it commences its course, nor pursue nor pollute the same.

ARTESIAN WELLS.

[Chapter 14. Acts of eighteenth session, 1889.]

AN ACT to provide for the sinking of artesian wells and construction of water-courses therefrom.

Be it enacted by the legislative assembly of the Territory of Dakota:

SECTION 1. [Commissioner created.] That for the purpose of carrying into effect the provisions of this act, the judge of probate of each county shall be *ex officio* county artesian well commissioner, which office is hereby created.

SEC. 2. [Application by ten resident freeholders.] Before the artesian well commissioner shall take any action toward creating or establishing any artesian well, there shall be filed with him an application, signed by not less than ten resident freeholders of any township or townships in which such artesian well and the lands to be benefited thereby and to be assessed therefor may be situated, giving a description of the place where said well is proposed to be located, and also a definite description of the beginning, the route, and the terminus of the water-way through which it is proposed that the water from such well shall flow when the same is completed and in operation, and offering the right of way for said well and such water-way through their said land, and who shall be subject to direct assessment therefor.

SEC. 3. [Appointment of viewers—duties.] At the expiration of twenty days after the filing of such application the said commissioners shall appoint three disinterested

persons as viewers who shall without unnecessary delay proceed to personally examine the place where said well is to be located and the course, route, and terminus of said proposed water-way, and shall ascertain whether said location of such well and establishment of said water-way is practicable and necessary and beneficial to the public welfare of the district in which the same is proposed to be located, and shall report the result of such investigations in writing to said well commissioner, having first been duly sworn to faithfully and impartially discharge their duties as such viewers. If any person upon whose land the proposed well is located or through whose land any water-way therefrom may pass, shall have filed any protest against the location of said proposed well and water-way, prior to the appointment of said viewers, they shall assess the damages, if any, which such person may sustain from the location of such well or said water-ways through his land, and shall report said damages with the report of their proceedings made as heretofore provided.

SEC. 4. [*Report when damages assessed.*] If a majority of the viewers assess and report damages in favor of any person protesting against the location of such well or its water-ways, their report shall be presented to the board of county commissioners of said county, and if said board shall consider the proposed well of sufficient importance to the public they shall order the costs and damages to be paid out of the county treasury; but if a majority report against the claims for damages of such person he shall be liable for the costs of such appraisalment.

SEC. 5. [*Power of county commissioners.*] If it shall be made to appear to the board of county commissioners that the damages assessed are unreasonable they may set aside such assessment, and in such case the artesian-well commissioner may order another appraisalment by different persons, under the same regulations as provided in the first appraisalment.

SEC. 6. [*Appeal to district court.*] Any person aggrieved by any decision of any board of commissioners had under this chapter may appeal therefrom to the district court, the same as provided relating to highways, bridges, and ferries. (Section 29, chapter 29, Political Code, 1217 General Laws.)

SEC. 7. [*Fee of viewers.*] The viewers appointed under the provisions of section 3 of this act shall receive the sum of two dollars per day for their services as described in said section, to be paid by the persons who signed the application for said well, who shall be severally liable to pay the same.

SEC. 8. [*Survey after favorable report—plat filed.*] If the viewers make and file a written report with said commissioners recommending said location and route as practicable, necessary, and beneficial the commissioners shall cause a survey and measurement of the location of said well and the line of the proposed water-way to be made by the county surveyor, and a plat thereof shall be filed in the office of the register of deeds of said county, and be subject to public inspection, and shall show the location of the well and the lines and route of the water-way therefrom.

SEC. 9. [*Order of location by commissioner—damages.*] Upon the filing of the plat and the minutes of said survey as provided in said section 5, the said commissioner shall make an order in writing in which he shall declare said well and said water-ways therefrom to be located in accordance with said plat and survey: *Provided*, That in cases where damages have been appraised and assessed, the same shall first be paid to the person entitled thereto, or paid into the county treasury for their use, before such lands shall be actually taken.

SEC. 10. [*Railway's contribution to water-way—penalty—collection.*] Whenever it is necessary to construct a water-way from any artesian well across the right of way or road-bed of any railroad company it shall be the duty of the railroad, when notified by the commissioners so to do, to make and maintain the necessary opening through said road-bed, and to build and maintain a suitable culvert. Notice in writing to make such opening and to construct such culvert may be served on such company as provided in the service of summons, at least thirty days before such railroad company shall become liable.

In case such railroad company shall refuse or neglect to comply with the provisions of this section, it shall be liable to a penalty of ten dollars for each day's refusal or neglect to make such opening and construct such culvert. The district attorney of the county in which such railroad company shall have refused or neglected to comply with the provisions of this section, shall upon complaint being made by the artesian-well commissioner bring suit to collect such penalty or fines, and it shall be his duty to prosecute the same to a final determination in any court having competent jurisdiction.

SEC. 11. [*Duty of road overseers, etc.*] All that part of such artesian well or artesian-well water course, which is laid and constructed within the limits of or across any public highway shall be under the jurisdiction of the overseer of public highways or road supervisors, and it shall be his duty to keep the same open and free from all obstructions, and when any highway is subsequently constructed along or across such artesian-well water-way then so much thereof as shall come within the limits of such highway shall also be kept open and free from obstructions as above provided.

SEC. 12. [*Name of well.*] In his order locating any well under the provisions of this act the artesian-well commissioner shall give the same a name by which it shall be known and recorded.

SEC. 13. [*Advertise for bids for construction—contract—security.*] After making said order locating said well and the water-ways thereof, the artesian-well commissioner shall proceed to advertise for bids for contracts for sinking or making such well, and constructing said water-ways. He shall give not less than sixty days' notice of the time and place where such bids may be offered and opened, by causing a notice thereof to be published, not less than eight weekly insertions, in the official paper of said county, such bids shall be filed with the county clerk of said county by the parties making the same, and shall be taken subject to the approval of the board of county commissioners of said county. No contract made by the artesian well commissioner shall be valid unless approved by the board of county commissioners of such county, and their approval indorsed thereon by the chairman of said board.

The artesian well commissioner shall contract with the lowest responsible bidder giving adequate security for the performance of the work.

Such security shall cover the completion of the job in the manner and within the time fixed in the contract, and the amount thereof shall be fixed by said artesian well commissioner. Said commissioner shall reserve the right to reject any and all bids, and may adjourn the time for receiving such bids from time to time by publishing a notice of such adjournment, but not in all more than sixty days from and after the time named in the first advertisement, for receiving such bids. The contract for sinking the well may be separate from the contract for constructing the waterways, and may be let to different persons. Whenever any such artesian well shall have been fully completed and final report thereof made by the well commissioner, to the board of county commissioners, the said board shall turn over the control and management of said well and appurtenances to the board of supervisors of the township wherein said well is situated.

SEC. 14. [*Board of assessment—Meetings.*]—Immediately after making his order locating said well, the artesian well commissioner shall notify the chairman of the board of county commissioners and the county treasurer of said county, who shall, together with said well commissioner, constitute a board of assessment herein. The county clerk of said county shall be the clerk of said board of assessment. The members of said board shall meet within twenty days after receiving said notice, and may adjourn from day to day until their duties are performed as hereinafter set forth.

SEC. 15. [*Mode of assessment and apportionment—Tax collection.*]—The said board of assessment shall make an estimate of the costs of constructing said artesian well and the said water-ways, for the purpose of raising the funds necessary for the construction of said well. They shall have power to apportion the costs thereof as follows:

(1) They shall create a county fund to be known as the Artesian Well Fund, and may levy an assessment upon all taxable property in said county, not exceeding two mills on the dollar, and the basis of value upon which the annual levy of the current or preceding year was made: *Provided*, That not more than one-tenth of the cost of any artesian well, or waterways therefrom, shall be paid out of said fund, and the amount so paid shall be applied to the payment of the expenses and per diem of the well commissioners, the viewers, surveyors, members of the board of assessment, damages for right of way, and other like incidental expenses.

(2) They shall determine what portion of the costs of said well and its waterways shall be paid by each of the townships in which said well or said water courses therefrom are situated: *Provided*, That in no case shall the amount apportioned to any one township exceed one-fourth of the estimated cost of such well and waterways, and the county clerk shall present a statement of such amount to the respective clerks of such townships if organized; and said board of assessment shall establish and determine the rate of assessment necessary in such townships to raise the amount so apportioned to such townships. It shall then be the duty of the officers of such townships, who have similar duties to perform in other matters of township revenue, to levy, and they are hereby empowered to levy, an assessment upon the taxable property of said township, not exceeding the rate fixed by the board of assessment for such township, which shall be placed upon the tax-list under the head of "General Township Tax for Artesian Well Purposes," and collected as other township taxes are collected, and shall be held by the county treasurer when collected as a distinct fund to be disbursed, as hereinafter provided, to pay for constructing such well.

(3) In addition to the foregoing general township and county assessments, the said board of assessment shall also make a special assessment against each piece and parcel of land directly benefitted by said well and said water courses, carefully adjusting the per cent. and amount of such assessments with reference to the relative distance of such lands from the well itself, and the water-courses, and the amounts so

apportioned shall be levied as a special tax upon said land, and shall be placed upon the tax list by the county clerk or auditor under the head of "Direct tax for artesian well," and shall be paid into the county treasury as other taxes, and kept by said treasurer in a special fund to pay for the cost of constructing said well and said water-ways; said assessment shall be for a sufficient amount with the general county and township tax aforesaid to pay for said well and water-ways.

SEC. 16. [*Annual installments.*].—Said board of assessment may provide that the entire amount necessary to pay for the construction of said well and water-courses, be levied and collected as above in one year, or they may divide the same into two, three, four, or five equal installments, one of which shall be collected the first year, and one installment each year following, provided that the portion designated as county and township tax shall all be collected the first year.

SEC. 17. [*Review of assessment—Appeal.*].—The owner of any lands directly assessed for the construction of any artesian well under the provisions of this act, who may feel aggrieved by such assessment, may at any time before such tax becomes delinquent, appear before the board of county commissioners of the county in which such assessment was made and ask to have said assessment, as to his property, reviewed, and said board shall have the right to raise or lower his assessment, so as to make it just and reasonable, and an appeal may be taken from the action of said board as in other cases.

SEC. 18. [*Disqualification by interest—vacancy—how filled.*]. No member of any county board, and no county officer, whose lands have been directly assessed under this act, shall act on the board of assessment. In case any member of such board is so disqualified, his place shall be filled by calling in the sheriff of said county, or, if said sheriff is so disqualified, the county coroner may act on said board.

SEC. 19. [*Benefits—principle of assessment.*]. All assessments of benefits under the provisions of this act shall be upon the principle of benefits derived. All descriptions of land under the provisions of this act shall be made by giving the legal subdivision thereof whenever practicable, and when the tract of land which is to be benefited or affected by such well is less than such legal subdivision it may be described by designation of the lot or other boundaries, or in some way by which it may be known.

SEC. 20. [*Additional assessment.*]. Whenever the amount assessed for the construction of any well shall not be sufficient to complete the same, and to pay all the costs and incidental expenses, a further assessment shall be made to meet the deficit or additional expense. Such further assessment shall be apportioned, assessed, levied, and collected as provided in the first instance, and on the same percentage, and shall be collected in one year.

SEC. 21. [*Enrollment of tax by clerk.*]. It shall be the duty of the county clerk to spread on his roll the total amount of all the well taxes determined upon by the board of assessment, to be assessed upon any township at large, as a part of the township tax for the year, and he shall also spread upon said roll separately, and immediately following the other descriptions, all tracts or parcels of land specially assessed for benefits, and shall place opposite each description the amount of taxes apportioned thereon for such benefits. All wells shall be entered separately, naming each well.

SEC. 22. [*Collection—mode of.*]. All taxes assessed under the provisions of this act shall be collected in the same manner as territorial and other general taxes are collected, and collecting officers are hereby vested with the same power and authority in the collection of such taxes as are or may be conferred by law for collecting general taxes. All taxes levied under the provisions of this act, with all lawful costs, interests, and charges, shall be and remain a perpetual lien upon the lands upon which they are assessed, and a personal claim against the owner or owners of such lands until they are paid.

SEC. 23. [*Sale for delinquency.*]. If the taxes levied for the construction of any well are not paid to the county treasurer as provided herein, he shall proceed to sell the said lands for such taxes, at the same time and in the same manner in every respect, as in the case of any other tax and with like effect.

SEC. 24. [*Compensation of officers.*]. The artesian well commissioner and the members of the board of assessment herein provided for, shall receive for their services a sum not to exceed three dollars per day for each day actually and necessarily spent by them in the discharge of their respective duties as hereinbefore described. All expenses, except on contract for constructing said well or such water-courses, shall be paid out of the general fund of the county on the order of the board of county commissioners, as other claims against the county are paid; said fund to be reimbursed, out of the first money collected under the provisions of subdivision 1 of section 15 of this act.

SEC. 25. [*Blanks drawn by attorney-general.*]. It shall be the duty of the attorney-general to draft a complete set of all the blank forms that may be required under this act, and county clerks are authorized, and it shall be their duty, to procure at the expense of their respective counties the necessary books and blanks to carry out the provisions of this act.

SEC. 26. [*Mode of payment to contractor.*] No payment shall be made to any person contracting to construct or sink an artesian well or any water-course therefrom under the provisions of this act except as follows: One-third of the amount to be paid for the entire performance of the contract may be paid when one-third of said work is done; one-third of said amount may be paid when two-thirds of said work is completed; but the balance of said amount shall not be paid until said contract has been fully completed and the work accepted and approved by the artesian well commissioner. The said payments shall be made in the following manner: The contractor shall make a statement of the amount claimed by him to be due under his contract, and if the same is correct it shall be approved by the artesian well commissioner, whose duty it shall be to carefully examine the work done under said contract; said claim so approved shall be presented to the board of county commissioners, and if correct they shall issue county orders or warrants upon the well funds of each particular well, naming it: *Provided*, That if the assessment of taxes for such well has been divided into installments, as provided in this act, said board shall not issue orders payable in any one year for a larger amount than the said installment for that year, but shall draw as near as may be to the exact amount of such installment. When such orders or warrants are presented to the county treasurer for payment, if he has not yet received sufficient funds to pay the same, then such orders may be indorsed and registered as other county warrants under the general law, and shall bear the same rate of interest as other warrants.

SEC. 27. [*Description of assessed lands filed with register—lien.*] The clerk of the board of assessment provided for in this act shall make a statement of the direct assessment for benefits made against the several pieces and parcels of lands, giving a description of such lands, the amount of the direct assessment against each piece or parcel, the name of the well for which the assessment was made, and shall file the same with the register of deeds of said county, and the same shall thereafter be a lien upon said lands to secure the payment of any orders or warrants issued as herein provided; which lien may be foreclosed by the holder of such warrants or orders, and shall be prior to all other liens except for taxes.

SEC. 28. [*Water-courses unobstructed, duty of overseer of highways.*] It is hereby made the duty of every person through whose land any water-course constructed under this act may pass to keep the same open and unobstructed. On failure so to do, any person aggrieved may complain to the overseer of highways in the district where such water-course is situated, and such overseer shall have the authority, and it is hereby made his duty, to call out the persons residing in said district who are liable for road tax, and open said water-way, and the expense thereof shall be entered by the county clerk as a tax against said land.

SEC. 29. [*Repeal.*] All laws heretofore enacted on the subject of artesian wells are hereby repealed: *Provided*, That all proceedings heretofore had and all contracts made under the provisions of existing laws on the subject of artesian wells are hereby declared to be valid and may be continued and completed under the provisions of this act.

SEC. 30. [*Effect when.*] This act shall take effect on the 1st day of July, 1889.

Approved March 8, 1889.

WATER RIGHTS UNDER THE CONSTITUTION OF THE STATE OF MONTANA.*

SECTION 1 The use of all waters now appropriated, or that may hereafter be appropriated, for sale, rental, or distribution; also, of all water originally appropriated for private use, but which, after such appropriation has heretofore been, or may hereafter be, sold, rented, or distributed, is hereby declared to be a public use, and subject to the regulation and control of the State in the manner prescribed by law.

SEC. 2. The right to collect rates or compensation for the use of water supplied to any county, city, or town, or water district, or the inhabitants thereof, is a franchise, and can not be exercised except by authority of and in the manner prescribed by law.

SEC. 3. The right to divert and appropriate the unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right as between those using the water for the same purpose; but when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same those using the water for domestic purposes shall (subject to such limitations as may be prescribed by law) have the preference over those claiming for any other purpose, and those using the water for agricultural purposes shall have preference over those using the same for manufacturing purposes.

* Delayed in transmission and inserted here in place of Montana division.

SEC. 4. All persons and corporations shall have the right of way across public, private, and corporate lands for the construction and maintenance of canals, ditches, flumes or pipes for the purpose of conveying water to the place of use, for any useful or beneficial purpose, and for drainage, upon paying therefor a just compensation in the manner prescribed by law.

SEC. 5. Whenever any waters have been, or shall be, appropriated or used for agricultural purposes under a sale, rental, or distribution thereof, such sale, rental, or distribution shall be deemed an exclusive dedication to such use; and whenever such waters so dedicated shall have ever been sold, rented, or distributed to any person who has settled upon or improved land for agricultural purposes with a view of receiving the benefit of such water under such dedication, such person, his heirs, executors, administrators, successors, or assigns shall not thereafter without his consent be deprived of the annual use of the same when needed for domestic purposes, or to irrigate the land so settled upon or improved, upon payment therefor and compliance with such equitable terms and conditions as to the quantity used and times of use as may be prescribed by law.

SEC. 6. Whenever more than one person has settled upon or improved land with the view of receiving water for agricultural purposes under a sale, rental, or distribution thereof, as in the last preceding section of this article provided, as among such persons priority in time shall give superiority of right to the use of such water in the numerical order of such settlements or improvements; but whenever the supply of such water shall not be sufficient to meet the demands of all those desiring to use the same, such priority of right shall be subject to such reasonable limitations as to the quantity of water used and times of use as the legislative assembly, having due regard both to such priority of right and the necessities of those subsequent in time of settlement or improvement, may by law prescribe.

SEC. 7. The legislative assembly shall provide by law the manner in which reasonable maximum rates may be established to be charged for the use of water sold, rented, or distributed for any useful or beneficial purpose.

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